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UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces an open competitive examination for Junior Metallurgist.

Applications for junior metallurgist must be on file with the Civil-Service Commission at Washington, D. C., not later than May 28th. The date for assembling of competitors will be stated on their admission cards and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies at the Engineering Experiment Station, U. S. Naval Academy, Annapolis, Md., and vacancies occurring in the Federal classified service throughout the United States in positions requiring similar qualifications.

The entrance salary in the District of Columbia is $1860 a year. After the probational period required by the civil-service act and rules, advancement in pay will depend upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointment outside of Washington, D. C., the salary will be approximately the same.

The duties will consist of general metallurgical work connected with the fabrication of manufactured articles, either ferrous or non-ferrous; general metallurgical work including process control, physical testing of metallurgical materials or ores, microphotography and research work on a large variety of metallurgical problems.

Competitors will be rated on practical questions on general metallurgy, chemistry, and elementary physics; and a thesis to be handed to the examiner on the day of the examination.

Full information may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.

The United States Civil-Service Commission announces open competitive examinations for occupational therapy aide (arts and crafts), occupational therapy aide (trades and industries), occupational therapy aide (general agriculture), occupational therapy aide (poultry raising), occupational therapy aide (gardening).

Applications for the positions named above will be rated as received by the Civil-Service Commission at Washington, D. C., until October 31st.

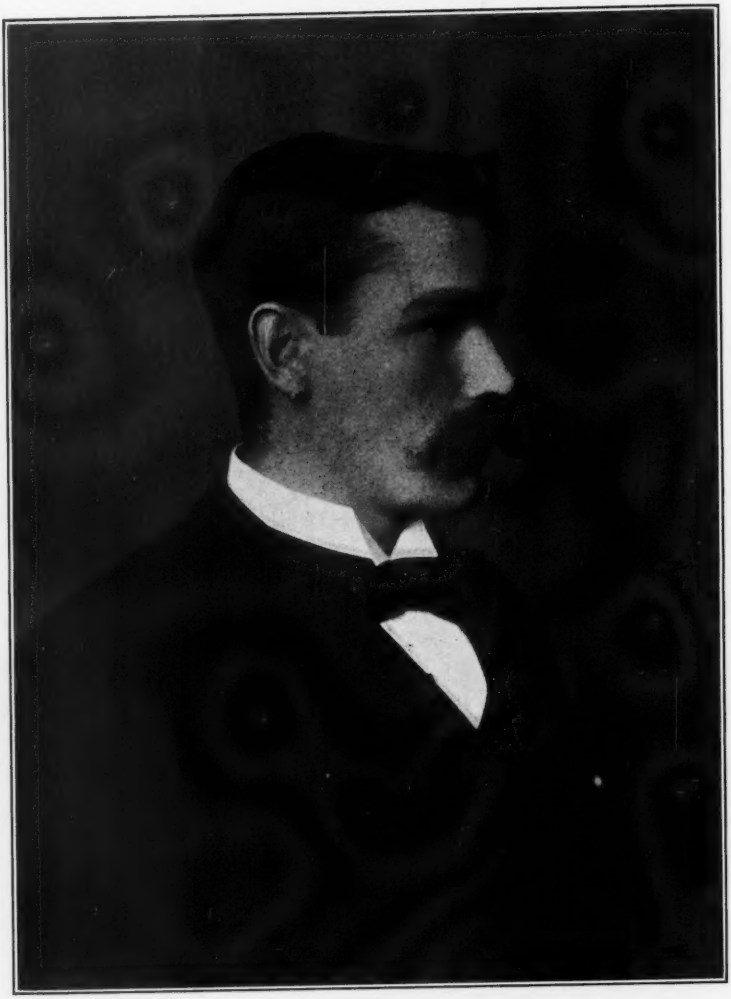
The examinations are to fill vacancies in the Veterans' Bureau throughout the United States, and in positions requiring similar qualifications.

The salary range is from $1680 to $2040 a year. The entrance salary is the lowest stated for the grade except where the isolation of the hospital or the character of the duties to be performed renders a higher remuneration necessary.

The duties will consist of administering treatment by means of the arts and crafts, trades and industries, or agriculture, keeping a daily record of the work and progress of each and every patient coming under direction and instruction, and making the required reports of occupational activities.

Competitors will not be required to report for examination at any place, but will be rated on their physical ability, and education, training, and experience.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.



ALEXANDER SMITH

EDITOR'S OUTLOOK

Edinburgh and a Distinguished Alumnus

LAST summer, in the course of a European tour, the editor was fortunate enough to have the opportunity of visting a number of famous universities, among them the University of Edinburgh. At that time Sir James Walker kindly agreed to prepare the description of the Chemistry Department at Edinburgh which appears in this issue.

Several well-known American chemists have received a part of their chemical training at that distinguished institution. One of that number—Dr. James Kendall—contributes, in introduction to Sir James Walker's paper, a brief account of the history of the University and of some of the outstanding figures which have been connected with it.

Of the alumni of Edinburgh probably none is better known to American students and teachers of chemistry than Dr. Alexander Smith, whose portrait appears on the opposite page. The likeness here presented perhaps would not be instantly recognized by those who knew him at Columbia, but it was selected with the thought that an unusual portrait might be of greater interest to our readers than a copy of one hitherto widely published.

Alexander Smith received the degree of Bachelor of Science from the University of Edinburgh in 1886, worked under von Baeyer at Munich, obtaining his Ph.D. in 1889, and returned to Edinburgh for one year as assistant in chemistry. He came to this country as Professor of Chemistry and Mineralogy in Wabash College but was soon called to assist in the development of the University of Chicago, where he remained for seventeen years. In 1911 he succeeded Professor Chandler at Columbia where he remained until serious illness compelled his retirement.

Concerning Alexander Smith as an educator we cannot do better than to quote from the obituary by Dr. Kendall which appeared in the *Journal of the American Chemical Society* for December, 1922.

> Few men have rendered more significant service to American chemistry. As a teacher, Alexander Smith in his prime had no equal, and his guiding principles have fortunately been put in permanent form in his famous series of textbooks. It is no exaggeration to state that the first issue of his "Inorganic Chemistry" in 1906 inaugurated a revolution in methods of instruction in America, comparable only with that effected in Germany by Ostwald's "Lehrbuch der allgemeinen Chemie." Instead of a hodge-podge of isolated facts, the student found in these volumes a clear and logical presentation of the fundamental principles of the science. A proper appreciation of the physico-chemical aspects of each topic under discussion constitutes, indeed, one of the main features of Alexander Smith's textbooks, and indicates clearly the strong influence exerted by Ostwald and his school upon his work. The success of Alexander Smith's methods may be estimated by the number of his followers; practically every modern inorganic chemistry is based upon his foundations. Not only have his volumes enjoyed

phenomenal popularity in this country and in Great Britain, but they have been translated into many foreign languages, including even Russian and Chinese.

Alexander Smith devoted much attention also to the manifold practical details connected with the teaching of chemistry, and a large number of his addresses deal with various aspects of this branch of his labors, ranging all the way from methods of laboratory instruction in high-school chemistry to the administrative problems of a large university department. It will suffice here to refer to two such lectures: "The Rehabilitation of the American College, and the Place of Chemistry in It," printed in *Science*, **30**, 457 (1909), and "The Training of Chemists," an address delivered in Urbana at the opening of the Chemical Laboratory of the University of Illinois, printed in *Science*, **43**, 619 (1916). His educational insight was rarely, if ever, at fault, and as an administrator he was untiring.

. . . . . .

In his last years at Columbia, Professor Smith's health was evidently weakening. Handicapped as he was also, during the war, in his task of running a gigantic department with a sadly depleted staff, these difficulties were still further increased by unfortunate controversies, and his final collapse was by no means unexpected. Those who may have formed their opinion of him during this period can have no conception at all of the inherent nobility and sterling character of the true Alexander Smith. His many friends, knowing his real worth, will long cherish him in their memory.

Investing the Summer

AS THE vacation season looms in sight progressive teachers begin to ask themselves how they may best make use of such time as is to be allotted them. Some will seize the opportunity to enter their laboratories and attack long-cherished problems; others will invade the libraries. Many are beginning to scan the summer-school announcements.

Colleges and universities, in general, give evidence of increasing awareness of the needs and desires of teachers of chemistry. Special courses arranged with a view to meeting these needs are numerous.

In addition to the usual offerings there is this year the Summer Institute of Chemistry at Pennsylvania State College, sponsored by the American Chemical Society. This includes features which should be attractive to a great many teachers. The lecturers have been selected from among the recognized authorities in their respective fields, and both Europe and America are represented. Morning classes and conferences, afternoons free for recreation, and evening lectures of a popular nature give promise of a thoroughly enjoyable as well as a profitable session. Excellent living conditions are offered at moderate expense and all plans are being laid with a view to facilitating and enhancing the pleasant associations which are so valuable a feature of projects of this nature.

A more extended account of the Institute is presented on pages 663 to 665 of this number and complete details may be had from Dr. G. L. Wendt of Pennsylvania State College.

A GLIMPSE AT THE PAST AND THE FUTURE IN CHEMICAL EDUCATION*

B. S. HOPKINS, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

A careful business man takes an inventory at intervals and formulates his plans of development. It is evident that the Secretary of the Division of Chemical Education is a business-like scientist since he insists that the newly elected chairman should review briefly the recent achievements in chemical education, should take an inventory of our present stock in trade and should summarize the lines along which future development may be expected.

With a desire to weigh as accurately as possible the present values attached to the recent efforts which have been made in behalf of chemical education and to receive reports from those who are engaged in the actual teaching of chemistry throughout the length and breadth of our land, your chairman sent out a questionnaire asking for brief but frank statements concerning the present status of chemical education. It was hoped in this way to learn whether or not progress was actually being made and to secure a representative, composite opinion concerning the most urgent needs toward which our efforts should be directed in the immediate future. The questionnaire contained two questions: (1) What in your opinion have been the most outstanding accomplishments in chemical education during the past five years? (2) What are the most outstanding problems in your region and how can they be solved? The replies to these questions have been given with thoughtful, conscientious effort, and I wish to express to all our sincere appreciation of the interest shown and helpful suggestions which have been made.

The answers to the first question have shown a singular uniformity of thought and appreciation. It is possible to group a large proportion of these replies around the three definite central thoughts of organization, adaptation, and expression.

The achievements of organization which have been mentioned include those of the Committee on Chemical Education and its efforts to bring together the discordant aims of varying interests; to unify to a degree the subject matter and purpose of courses of study; and to gain recognition of the educational and cultural value of scientific training in such a subject as chemistry. The organization of the Senate of Chemical Education with its broad plan and democratic responsibility extending into every region of the country where chemistry is taught; the multiplication and growth of state and regional associations of chemistry teachers with their community of interests and spirit of mutual helpfulness; the stimulation

* Address of the Chairman to the Division of Chemical Education of the A. C. S. at Richmond, Virginia, April 13, 1927.

of interest in the American Chemical Society among the hundreds of teachers of chemistry who have never before found that the activities of our society have had immediate value for them—all of these results have impressed upon our minds the lesson of the constructive value of organization. It is fitting that while we are assembled at this time and in this place, we acknowledge anew the truth of the historic phrase: "In union there is strength."

Another great achievement of the recent past has been the bringing of chemistry out of its cloistered academic setting of the class room and making of it a living active force which touches the life of our modern civilization at a multitude of angles. The casual reader, the busy industrialist, the specialist in other fields and the man on the street, each now has the opportunity of learning the place of chemistry in our modern life and its rapidly increasing value to civilization. Anything the value of which is known and appreciated will not be allowed to suffer from lack of support in this forward-looking age of ours, and so chemistry will be wise if it continues to use all possible means of educating the public concerning matters of its own interest.

In many respects the one big achievement in chemical education of the past five years has been the establishment of a means of expression among teachers, such as the JOURNAL OF CHEMICAL EDUCATION, since it in a very definite way contributes largely to the other steps which have been made. To establish such a journal, to bring its paid circulation to the present figure within three years, to build up a magazine which is rapidly coming to be regarded as marking a new era in chemical education throughout the world, to win support from all parts of this and other countries, certainly these are achievements of no small value. To Neil E. Gordon as editor, to Erle M. Billings as business manager, to Francis P. Garvan as generous and loyal supporter and to the numerous workers who have labored together to produce one of the finest accomplishments of coöperative effort, our sincere thanks are due. The JOURNAL has done much and it needs the united and persistent effort of every teacher of chemistry in order that it may continue to thrive and to come to a full measure of its opportunities.

In speaking of the work already done as "achievements" it must not be assumed that no further work along these lines is needed. Definite steps in advance have been made but everlasting vigilance is needed in order to hold the advantages which have been gained. This is no time to relax our efforts, but it is necessary to continue our work to secure in greater degree the benefits of organization to broaden the measure of adaptation and above all to sustain with ceaseless and unwavering coöperation our own JOURNAL OF CHEMICAL EDUCATION as the one great means of expression for teachers of chemistry.

Turning now to the second question, that relating to problems of the future, it is still more surprising to find that by far the largest majority of answers may be grouped about two single thoughts: (1) standardization of instruction and (2) better training for the future teachers of chemistry. Only the briefest reference to each can be made here.

College officers who deal with entrance requirements or with transfer students are urging that more attention be paid to certain fundamental essentials. Better correlation between the course in preparatory school and in college is needed in order that serious overlapping may not occur. It is also desirable that our college courses in chemistry should be made to correlate more closely with each other and with other sciences. While these problems will not be easily solved, it is only by patient, persistent effort that progress will be made.

A grave responsibility rests upon this generation of chemists because we must of necessity train the future teachers of chemistry. If we could be sure that this task will be done with one hundred per cent thoroughness and efficiency, most of the serious problems in the chemical education of the future would be taken care of automatically. A good teacher will do good teaching in spite of handicaps and discouragements. If chemistry is to endure, one of the problems which our generation must take up seriously and with all thoroughness is the training of teachers from whom we may expect a better job of teaching than we are doing.

It would be little short of foolish to attempt, within the limits of this brief summary, to give all the attributes desired in the ideal teacher of the future. But it may perhaps be permissible to gather from the various answers to our questionnaire a few of the characteristics which are required in the light of our present needs. The ideal teacher must possess professional pride in his work; he must inspire his associates to larger achievements and hold up to his students a vision of the service which chemistry may be expected to render to humanity; he must adjust his subject to the needs of his situation so thoroughly that it will become indispensable and will bring into being the best of equipment and teaching conditions; he must teach long hours, while he finds time to do research, attend meetings of the American Chemical Society and keep in touch with advancement in the subject, even though he is handicapped by the limitations of geographical isolation and meagre financial returns; he must teach the fundamentals and the recent developments remembering all the time that education consists in developing the mind rather than the memory. These are difficult goals to reach, but the more nearly we can approach them the more surely will the advancement of chemistry be assured.

But the training of the teacher does not stop with the granting of his diploma—it has in fact barely begun. The training of experience, benefitting by the suggestions of others, keeping pace with the changes in a

rapidly growing science, and all the while reaching toward a maturity of experience and judgment—these are a vital part of a successful campaign in chemical education. Can any other agency supply this phase of training more effectively than an Institute of Chemical Education? Until such an agency can be brought into full operation, it is suggested that in each state there be established a Service Bureau for teachers of chemistry, to which may be referred some of the more pressing problems of the isolated teacher.

There are many tasks to be undertaken and these will require the combined effort of all who are interested in the cause of chemical education. Let us undertake the work with enthusiasm, encouraged by the success of the past, fortified by the high regard in which chemical education is held and fully aware of such dangers as those of over-satisfaction with our own progress, over-standardization in our methods of work and over-organization in the machinery which we use.

It is impossible in a few brief pages to summarize all the splendid suggestions which have been made by our colleagues in chemical education. Permit me, after this highly unsatisfactory effort at bringing together the widely divergent opinions which have been expressed, to suggest as our present motto the slogan: "Hats off for the accomplishments of the past; coats off for the tasks of the present and the future."

COLLEGE ESSAY PRIZE WINNERS

Mr. Paul Smith, Secretary of the Committee on Essay of the A. C. S., announces the following winners for 1926–27 in the prize essay contest for university and college freshmen:

"The Relation of Chemistry to Health and Disease," Miss Paula M. Horn, State University of Iowa, Iowa City, Iowa.

"The Relation of Chemistry to the Enrichment of Life," S. N. Alexander, University of Oklahoma, Norman, Okla.

"The Relation of Chemistry to Agriculture," Mr. Caryl Parker Haskins, Yale University, New Haven, Conn.

"The Relation of Chemistry to National Defense," Mr. Culbert Rutenber, Georgetown College, Georgetown, Ky.

"The Relation of Chemistry to the Home," Miss Catherine D. Barnsley, University of Maryland, College Park, Md.

"The Relation of Chemistry to the Development of an Industry or a Resource of the United States," Miss Gracia Greenhill, Goucher College, Baltimore, Md.

THE UNIVERSITY OF EDINBURGH

JAMES KENDALL, NEW YORK UNIVERSITY, NEW YORK CITY

Edinburgh University is the youngest of the four universities of Scotland. It is, in fact, the only one of the four which does not date back to pre-reformation times, the famous Presbyterian, John Knox, being among its founders. The chair of chemistry in the university was originally connected with the Faculty of Medicine, and only in very recent years has the connection been finally broken by the establishment of a separate department of Medical Chemistry. The phrase "chair of chemistry," it may be mentioned, possesses a somewhat more literal significance at Edinburgh than at any other university, since the chair in which its most distinguished occupant—Joseph Black—actually sat is still in the use of the present professor.

The pioneer work of Black on *magnesia alba*, which led to the important conclusion that the "burning" of lime consisted essentially in the loss of fixed air, not in the addition of phlogiston, is too well known to need detailed description. The discovery of nitrogen by Rutherford, professor of botany at Edinburgh, is another landmark in the history of our science which does not need elaboration here. A brief account of the main achievements of some of the more recent investigators in chemistry at Edinburgh, however, may be of service in providing a proper perspective to the article by Sir James Walker which follows.

The immediate predecessor of Sir James Walker at the University of Edinburgh was Alexander Crum Brown, professor of chemistry for a period of 39 years, from 1869 to 1908. Innumerable stories are current regarding Crum Brown, and the best of them are probably apocryphal. It may not be really true, as legend states, that he was offered his choice of three chairs—chemistry, midwifery, and English literature—at the age of thirty. The story that he undertook the examination of an oriental student who offered Chinese as a language requirement, *and flunked him*, has a somewhat firmer foundation. What is quite certain is that Crum Brown was one of the most versatile, as well as one of the most original and energetic men that Scotland ever produced. Originally an organic chemist, he was the first to use lines to indicate the valence and linkage of atoms in organic compounds, and in his doctor's dissertation in 1861 he had already evolved a system of graphic formulation which is essentially identical with that now in use. In later years he postulated (with Gibson) the familiar Crum Brown-Gibson rule for determining the position in the benzene nucleus taken up by an entering radical with respect to one already present, and devised (with Walker) the method for the synthesis of dibasic acids by the electrolysis of ester salts.

Crum Brown's interests, nevertheless, were by no means limited to the

organic field. His article on "The Molecule," written for the 9th edition of the Encyclopaedia Britannica in 1883, contains the following remarkable statement, which illustrates his keen prophetic vision into the domain of physico-chemical theory: "It is perhaps scarcely correct to speak of a molecular structure of solids at all. Solids are no doubt composed of atoms, and these atoms are evidently arranged in what may be called a tactical order." The continuation of the article shows that Crum Brown had mastered, more than forty years ago, the essential features of our modern idea regarding the structure of solids. Long before the work of Laue or of Bragg, indeed, Crum Brown had constructed a model of the rock-salt crystal identical with that now exhibited to every freshman. The third dimension always intrigued his fancy. In his retiring room, behind the lecture theater, he would spend the intervals before and after lectures in constructing models with the help of cardboard and glue-pot, and he whiled away many leisure hours after his retirement in designing original methods of three-dimensional knitting!

The recognition of the importance of mathematics in chemistry was another point in which Crum Brown moved in advance of his times. In his presidential address before the Chemical Society in 1892 he stated: "Unless the chemist learns the language of mathematics, he will become a provincial, and the higher branches of chemical work, that require reason as well as skill, will gradually pass out of his hands."

A contemporary of Crum Brown at Edinburgh, equally able but far less fortunate in his chemical career, was Alexander Scott Couper. Couper, while a graduate student in the laboratory of Wurtz at Paris, worked out a new chemical theory in which the hypothesis of the quadrivalence of carbon and the structural formulas of chain compounds were discussed at length. He handed in his article to Wurtz to present it before the Academy. Wurtz was not then a member, and it was necessary for him to deliver the manuscript to Balard. He delayed doing this for a short time, and consequently Kekulé's famous contribution on the same topic appeared before that of Couper was presented to the public. Couper was terribly upset, as can be imagined, and let his professor know it, not too tactfully, with the result that he was shown the door of the laboratory.

Misfortune still pursued him. He published, a little later, a very fine experimental article entitled "Researches on Salicylic Acid," in which he investigated its action with phosphorus pentachloride. Several better-known investigators, including Kekulé and Kolbe, repeated his work, but were unable to confirm his results. Only long afterwards, when Couper had retired broken-hearted from the scientific field to die, practically unknown, in his native country, was it finally discovered that he was in the right on every point.

During the decade 1880–90, when systematic physical chemistry was

first beginning to raise its head, there grew up at Edinburgh an unusual number of outstanding chemists. Among them may be mentioned here the names of Alexander Smith, David Orme Masson, and James Walker. Alexander Smith, after working under Baeyer in Munich, came to America and taught successively at Wabash College, the University of Chicago, and Columbia University. His research work on the allotropic forms of sulfur and on vapor density determinations was recognized both in this country and abroad as of the highest merit. He was a President of the American Chemical Society, an energetic teacher, and an able administrator. His series of textbooks is familiar to all chemists, and has exercised a unique influence on the progress of chemical education in this country.

Sir David Masson is now professor of chemistry in the University of Melbourne. His son, James Irvine Masson, holds the Chair of Chemistry at Durham University. Both father and son are well known in the fields of inorganic and physical chemistry.

The work of Sir James Walker, like that of Crum Brown, has not been restricted to any single field, but includes inorganic, organic, physical and—as will appear below—industrial chemistry. The main thread running through his research problems, however, is physical chemistry. An early student of Ostwald at Leipsic, Sir James Walker was among the first to preach the gospel of ionization in Great Britain, and several of its most significant chapters—for example, those on hydrolysis and amphoteric electrolytes—were largely written by him. His textbook on Physical Chemistry, first published in 1899, has now run through nine editions, and still affords the most readable approach to the subject.

During the early part of the World War, when the Allies' supply of high explosives became lamentably deficient, Sir James Walker organized a staff from the teachers, graduates, and undergraduates of the chemistry department at Edinburgh to produce TNT in a disused chemical factory in the city. Later on, the erection and management of a larger factory at Craigleith, a few miles distant, was undertaken by this same staff, and there as much as 50 tons of TNT were manufactured. The efficiency of the plant may be illustrated by the statement of the Department of Explosives Supply that its figures for nitrogen economy during the months of September and October, 1918, constituted a record for the country. Nevertheless, to quote from an address delivered to the London Chemical Society, "it is certain that if the production had continued, an immediate further saving of at least 2 per cent would have been effected, the alteration in the plant necessary to secure this being practically ready at the date of the armistice."

In view of this accomplishment, the following commendation accorded by Sir James Walker to his colleagues in the work is worthy of notice:

"If I may draw a moral for the academic chemist from our experience, it is that he need not fear to enter the chemical industry provided he has common sense, energy, a competent knowledge of his subject, and a willingness to coöperate with engineers and men of technical experience. These qualities suffice for any chemical routine manufacture, and if he is possessed, in addition, of far-sightedness and a spark of imagination, he may, I think, venture with confidence on novel methods and new chemical industries."

Among the honors bestowed upon Sir James Walker for his scientific achievements we may note here the Presidency of the London Chemical Society and the recent award of the Davy Medal of the Royal Society.

The above scant outline is not to be regarded as a history of chemistry at Edinburgh University. It represents merely a selection of the work that has been done, and is being done, there, and of the men who have done, and are still doing it. No mention has been made, for example, of such outstanding figures as Hope (the discoverer of strontium), Nicol (the inventor of the Nicol prism), Lord Playfair (who discovered the nitroprussides), Graham (who published his law on the diffusion of gases while a student in the department), Dewar (who discovered at Edinburgh the use of charcoal in the production of high vacua and laid the foundation of his later work on the liquefaction of gases and the production of low temperatures), and Hugh Marshall (the discoverer of persulfates). A point which is worth noting, however, in THIS JOURNAL, is the stimulating influence which has been furnished to all interested in chemistry in the university for many student generations through the activities of the Chemical Society of the department. Many distinguished names are on the roll of the officers of this society, and the real history of the department in recent years is written in its minutes. A very important series of publications for which certain of its former members are responsible is the set of Alembic Club Reprints, familiar to all enthusiasts in the study of the history of chemistry.

Edinburgh has the reputation of being the most cosmopolitan of British universities. In some of its departments, the English students almost outnumber the Scots, there is a heavy sprinkling of Welsh and of Irish, while Canadians, Australians, New Zealanders, and South Africans abound. That American visitors, although not numerically strong, have exercised a significant influence upon the student body in the past is evidenced by the fact that the University song, "The Son of a Gambolier," religiously chanted before all lectures, is drawn from this side of the Atlantic. The average American student, indeed, will find that life at Edinburgh conforms, in most respects, remarkably closely to his previous ideas and ideals, and that adjustment to his new environment can be made there with much less difficulty than at certain of the older English universities. The new

chemical laboratories, described by Sir James Walker, are among the most extensive and best equipped in any country, and it is to be hoped that many graduate students from America will take advantage in the near future of the opportunity to work in them and to absorb their quota of the spirit of true science with which they are permeated.

Lime Used in Butter and Sugar. Lime, familiar in building operations, is also of use to the dairyman, O. R. Overman, assistant professor of dairy chemistry at the University of Illinois, told members of the American Chemical Society in Richmond in a symposium on lime and its chemical aspects. This use of lime, he said, has come with the development of dairying as an industry with a scientific basis. It has been found that when lime is added to cream used in butter making, it neutralizes the acids formed, resulting in a greater yield of butter and increased keeping properties.

Other members of the society told of the use of lime in the beet sugar, tanning and paper industries. The chief need of the industry itself is to make suitable lime at a profit, Prof. J. R. Withrow, of the Ohio State University, told the symposium. The lime manufacturers, he said, give the best of their product to the building trades, and what is left to the chemists. As the building use of lime varies with the seasons, the result is a variable quality of the lime reaching the chemist, and damages the manufacturer in the eyes of the chemist.—*Science Service*

Plants and Animals Need Manganese and Copper. Manganese, best known through its use in alloy steels, and the common element copper are needed in microscopic quantity to maintain good health in plants and animals, according to Prof. J. S. McHargue of the Kentucky Agricultural Experiment Station, who spoke before the meeting of the American Chemical Society in Richmond. Dr. McHargue said, in part:

"Carefully controlled experiments show that plants will not grow in sand cultures containing adequate amounts of purified compounds of the so-called ten essential elements after the plant food material contained in the parent seeds has been exhausted. The addition of a small amount of a manganese compound causes a very marked increase in the growth of the plant and a small amount of copper in addition to manganese makes larger and more nearly normal plants.

"Small amounts of manganese and copper are normal constituents in the tissues of animals. Marine and fresh water mollusks are quite rich in manganese, copper, and zinc. Birds apparently contain more manganese than some of the higher types of domestic quadrupeds. The liver, kidneys, spleen, pancreas, heart, and brain contain more of these elements than the lean muscular tissues or the blood."—*Science Service*

Rubber and Aluminum Make Protective Paints. The advantages of rubber and aluminum as paint materials were outlined in two addresses before the American Chemical Society meeting in Richmond.

Harold Gray, research chemist of Akron, Ohio, told of the development of a protective paint from rubber. Its chief advantages, he stated, are resistance to corrosive chemical action, low permeability to liquids, especially salt solutions and sprays, toughness and flexibility even at sub-zero temperatures, and absence of flaking when cut.

Junius D. Edwards and Robert I. Wray of New Kensington, Pa., set forth the advantages of aluminum powder in paint as a moisture-proofing agent. The best protection, they stated, is given when all the coats of paint contain aluminum, but excellent effects may be obtained by its use in the priming coat alone.—*Science Service*

THE CHEMISTRY DEPARTMENT OF THE UNIVERSITY OF EDINBURGH

SIR JAMES WALKER, EDINBURGH UNIVERSITY, EDINBURGH, SCOTLAND

One of the University departments which suffered the greatest congestion after the War was that of chemistry, and to relieve this congestion the University resolved to build a new chemical laboratory for students of science, leaving the old laboratory, which was housed in the medical building, entirely for students of medicine.

The site selected is on the southern outskirts of the city and is over a hundred acres in extent. Of this the chemical laboratory with its approaches utilizes about four acres. Operations were begun at the end of 1919 and the laboratory was built in three sections, the last section being occupied in 1924. The cost of the building and equipment was approximately $1,000,000.

SIR JAMES WALKER

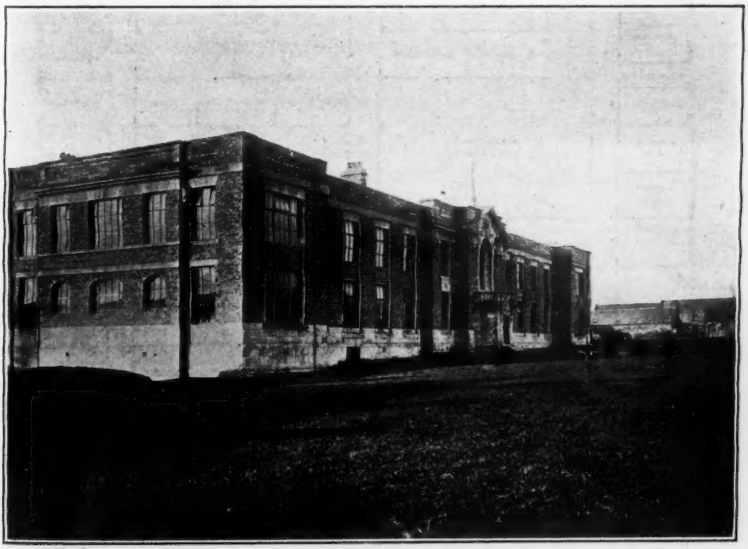
The laboratory, of which a photograph of the front elevation and a plan of the ground floor are annexed, is in the main of one story. The front block, however, is two stories in height, the upper floor housing the library, administrative offices, and special research rooms. The chief laboratories, situated between the central and side corridors, are lit from the roof which is of saw-tooth form with the lights facing due north. The plan admits of indefinite extension by lengthening the building toward the back, and if necessary a second story can be placed on top of the side rooms. There are in the building over 30 research rooms, the smaller rooms accommodating two researchers, and the larger three or four. There are four lecture rooms, all served from the same museum and preparation room.

A small technical section is equipped with service pipes for gas, steam, water, compressed air, and electricity round the walls, miniature plant being connected to these as required.

The ventilation of the laboratory is on the extraction system, fresh air entering by a duct under the central corridor, and passing from chambers under the laboratories and lecture rooms over heating pipes or radia-

tors into the apartments themselves. Each main laboratory is provided with a separate fan operating draught-holes on the working benches, there being in addition two large special fans for the draught cupboards of the building. A scavenging fan, set high in the end wall of each laboratory, removes any accumulation of fumes.

The laboratory accommodates about 250 undergraduate students working simultaneously. There is a senior staff of nine, and a junior staff of seven.

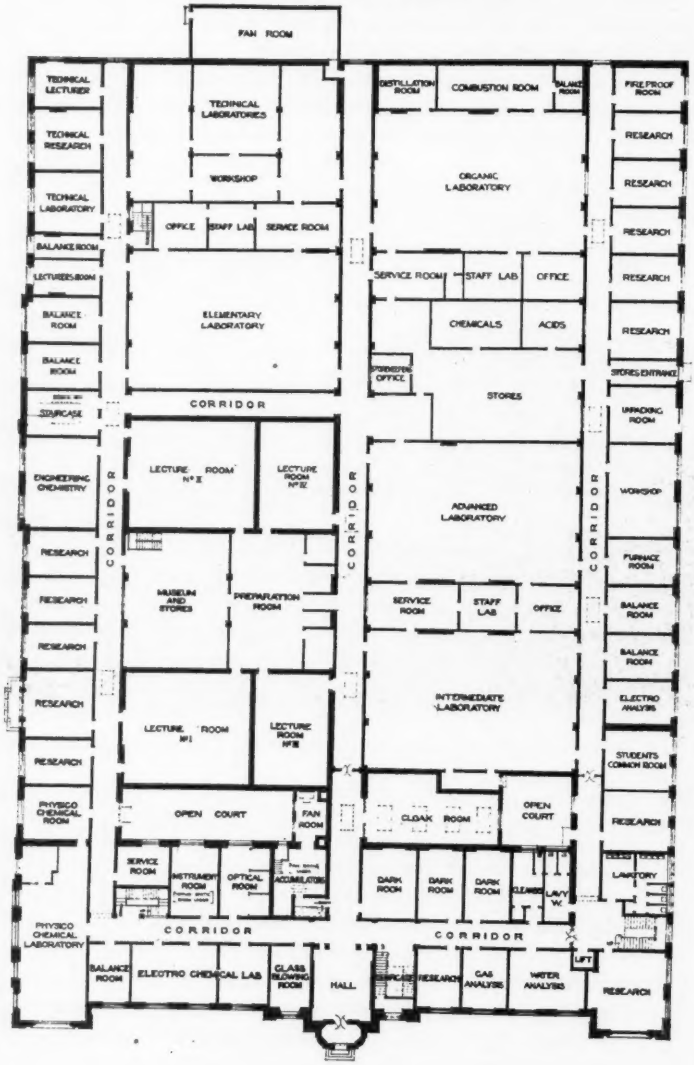


FRONT ELEVATION OF THE CHEMISTRY LABORATORY, UNIVERSITY OF EDINBURGH

The equipment for post-graduate work is ample, and the following list gives lines of research recently or at present being followed:

Action of alkalies on formaldehyde.
Condensation of diphenyl-formamidine with phenols.
Polarity effects in aromatic halogen compounds.
Optical activity and the polarity of substituent groups.
Electrosynthesis of long-chain dibasic acids.
Anode phenomena in electrolysis and the mechanism of electrosynthesis.
Reciprocal salt-pairs.
Slow oxidation of phosphorus and phosphorus trioxide.
Action of phosphorus on metallic salts.

EDINBURGH UNIVERSITY
CHEMISTRY DEPARTMENT



PLAN OF GROUND FLOOR

Diffusion in solution.
Common ion effect on solubility.
Thermal decomposition of oxalic acid and oxalacetic esters.
Influence of lyophilic colloids on the precipitation of insoluble salts.
Influence of non-electrolytes on stability of colloids.
Ultra-violet emission spectra of the halogens.
X-ray crystal analysis of organic acids.
Melting-point curves of mixtures of optical enatiomers.

The courses generally taken by students for the degree of B.Sc. with Honors in Chemistry are:

First Year—Mathematics, Physics, Chemistry
Second Year—Physics, Chemistry
Third Year—Chemistry, Mathematics (or other approved subject)
Fourth Year—Chemistry.

If the student desires to specialize on the biochemical side, he takes physiology or bacteriology instead of physics in the second year, and biochemistry instead of mathematics in the third year.

The University grants the degree of Ph.D. to graduates of approved universities who are capable of prosecuting scientific research. The period of full-time work required is two academic years, at the end of which time a thesis may be presented. The degree of D.Sc. is also conferred on a similar residence, with the proviso that a period of five years must have elapsed since the time of original graduation before a thesis can be presented. The essential difference between the two research degrees is that the standard for the D.Sc. degree is higher and that the work must be an original contribution to science, not conducted under supervision as may be the case for the Ph.D. degree. The fees for post-graduate workers in chemistry amount to about $90 per annum. Applications for admission as a Ph.D. research student should be addressed to the Registrar of the University, should state the degrees already obtained, and should be accompanied by a statement of the professor of chemistry under whom the candidate has worked that he is capable of undertaking research work in chemistry.

A considerable number of scholarships and fellowships exist for post-graduate research work in science, but these are, in general, only available for graduates of the University of Edinburgh.

Scientific thought does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.—W. K. CLIFFORD

THE STORY OF A GRAIN OF CORN. I. MANUFACTURING PROCESSES

W. R. CATHCART, CORN PRODUCTS REFINING COMPANY, NEW YORK CITY

Examination of the corn grain discloses certain constituent parts having widely different properties and values. The separation of these components, their transformation into products of increased value, and the development of uses for these manufactured materials are the important functions of the corn products industry.

Since the extension of the uses of products manufactured from corn increases the demand for this most important agricultural commodity, and, therefore, must enhance the price received by the corn grower, the mutual interest of the farmer and the manufacturer of products from corn in the fullest development of this industry is beyond question.

It is purposed to discuss three phases of this broad subject: Manufacturing Processes, Products and Their Uses, and The National Economic Importance of the Industry.

To attempt to cover details of processes in this rather limited discussion would be both impossible and undesirable. It is hoped that the outline presented will give the reader a clear picture of at least the principles involved.

Preparatory Operations

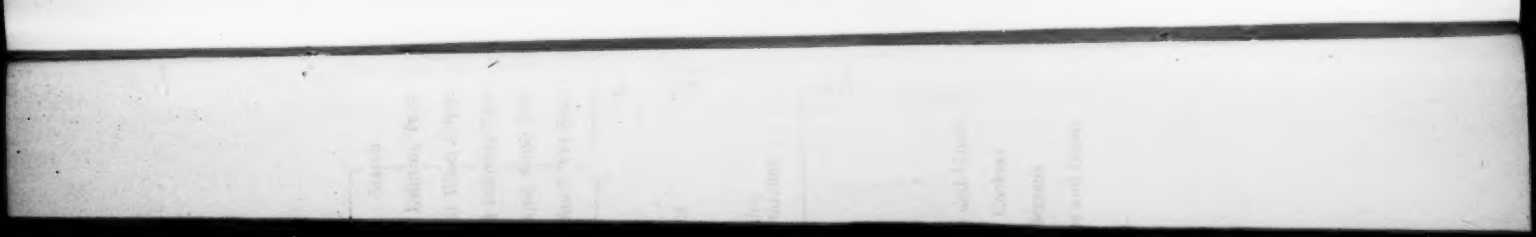
The shelled corn received at the plant is first freed from incidental dirt and foreign material and stored in large reservoirs to be drawn upon as needed.

The grain of corn has an exterior covering or integument consisting principally of cellulose. This hull surrounds the endosperm or main portion of the kernel, which consists of a mixture of starch and gluten, nitrogenous material. Within the endosperm and near the apex or pointed portion of the kernel is the germ, containing the oil and some fibrous material. In addition, there are certain solubles, principally on or near the surface of the grain. The first objective in the process is to separate these various constituents as completely and economically as possible. This separation is accomplished in the main as follows:

Steeping

The steeps are large cylindrical structures, usually of wood and cast iron, capable of holding 2500 bushels of corn. Warm water containing a small amount of SO_2 gas is circulated over the grain until the kernels have become softened. The SO_2 serves two purposes. It aids in softening and prevents fermentation of the grain at the temperatures used. The steep water after this operation contains most of the solubles present

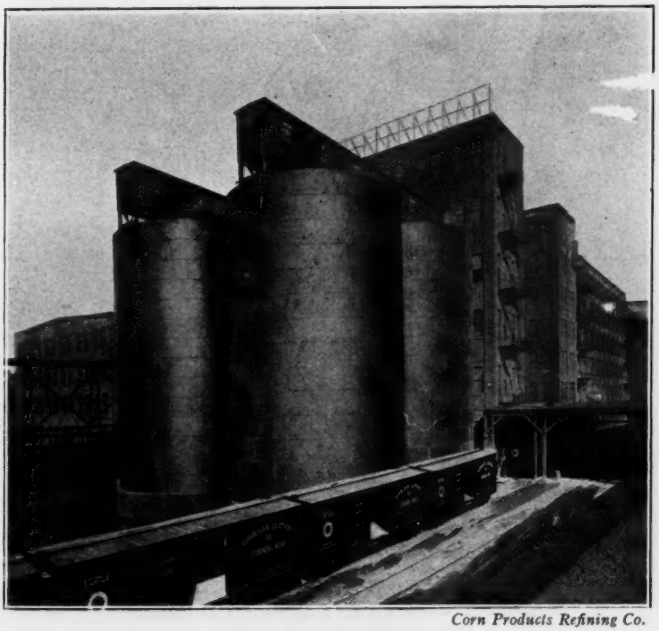
THIS CHART WILL BE THE FIRST CHART
APPEARING AT THE END OF THIS FILM



in the corn. This water is concentrated by evaporation and used as an important constituent of the cattle feed.

Crushing, Grinding and Reeling

The softened kernels are passed through disintegrators with a considerable amount of water to maintain proper gravity. The whole grain is crushed, but particularly the germs are freed, and due to their lower specific gravity float when the crushed mass is collected in tanks called "germ separators." These germs are removed with surprising complete-



Corn Products Refining Co.

Corn Storage Tanks

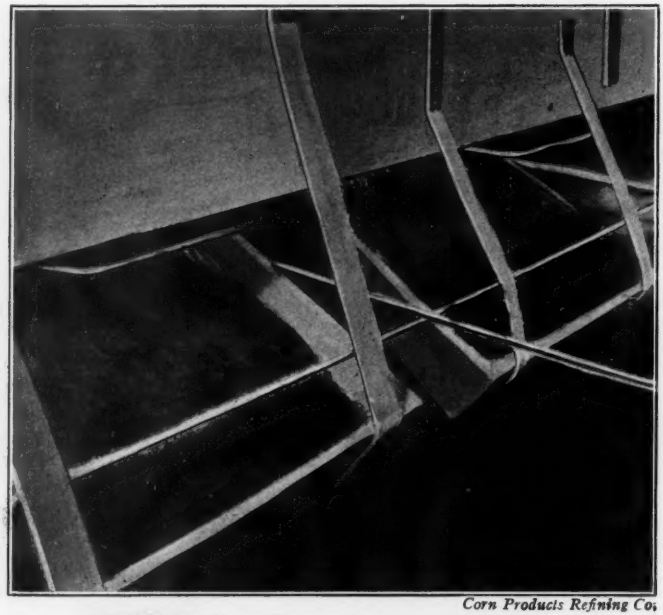
ness by a skimming process. The collected germs are washed, dried, ground and put through expellers to remove the oil. The resulting extracted mass still contains about 10% of oil which, with the solid matter, becomes a constituent of the cattle feed. Of the oil obtained, the greater part is refined and marketed as edible oil for various food purposes. As crude corn oil, it is suitable for soap-making and other industrial uses.

The magma remaining after the removal of the germs contains the starch, gluten, and fibrous material, cellulose. This mixture is finely ground and passed through various stages of washing and screening (reels)

which accomplish the complete removal of the fibrous cellulose material. This cellulose is collected and dried and finally finds its way to the cattle feed.

Tabling

The elimination of the cellulose leaves the starch and gluten mixed with water in a cream-colored suspension. This liquor is then allowed to flow over long, narrow, comparatively shallow, and slightly inclined troughs known as tables. Owing to its higher specific gravity, the starch



Corn Products Refining Co.

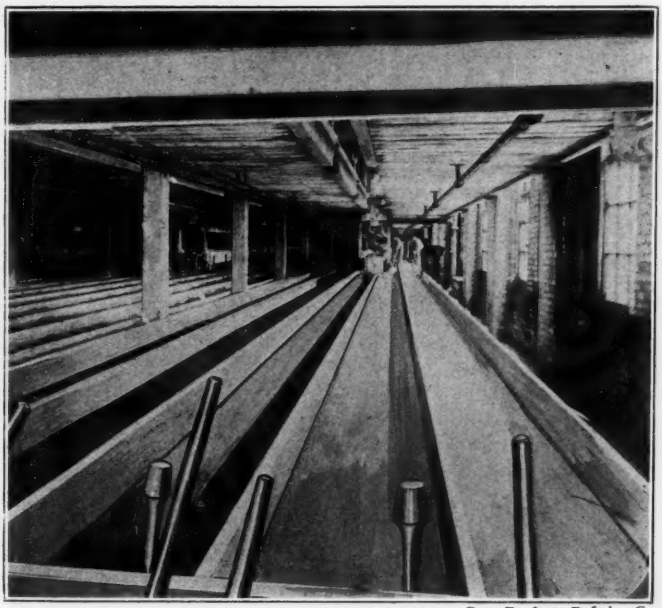
STEEPED CORN PASSING DOWN TO CRUSHERS

settles out and collects on the bottom of the tables and the gluten suspended in the water follows the overflow.

The gluten-containing water is collected in large reservoirs in which the gluten is settled out, then filter-pressed and dried. In this condition, the gluten is incorporated in the cattle feed in proportion to the amount of protein desired. The water from the gluten settlers is returned principally to the steeping process and thus finds its way again through the system.

The wet starch on the tables is already in a surprisingly high state of purity. There is, of course, a small amount of gluten and fiber present,

as well as solubles dissolved in the water retained. Formerly, it was customary to remove this wet starch by shovels and dry in the kilns without further treatment. This product represents the crudest form of starch commercially possible. Today, for the most part, the starch is flushed off the tables with large quantities of water and filter-pressed, which treatment reduces the solubles, and after drying, gives a purer starch. In some cases, the tabling process is repeated to reduce the gluten and fiber content and also the percentage of solubles. The treatment



Corn Products Refining Co.

Starch Tables

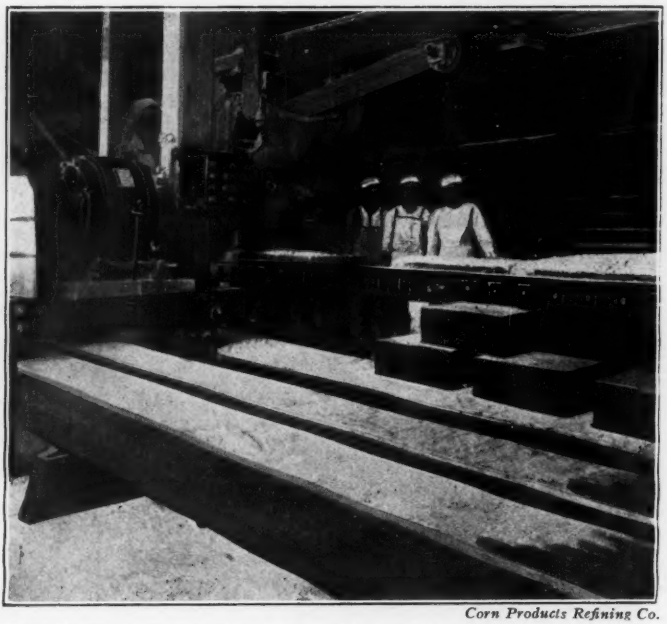
depends upon the grade of starch desired and the uses to be made of the final product.

Thus is obtained the product which may be regarded as the crude material for several important branches of the starch industry.

Starch

The starch obtained from the tables, by way of the filter-presses, is sufficiently pure for many purposes and carries about 45% moisture. This moisture is removed by drying in kilns, through which a current of hot air circulates at carefully controlled temperatures. If the drying

is completed within a few days, the product obtained is a mixture of starch powder, and larger particles usually called "starch crystals." Starch in this form is commonly known in commerce as "pearl starch" and contains from 12.5 to 13.5% moisture. To obtain "crystal starch" the wet starch is usually placed in the kilns in the form of a compact cube and the drying process prolonged, sometimes for weeks. In this way, due to the contraction of the wet mass, irregular lines of cleavage are



Corn Products Refining Co.

DRY STARCH READY TO BE BROKEN UP AND FURTHER DRIED IN KILNS

formed and finally the mass collapses in the form of what may be described as irregular, distorted prisms, called "crystals."

Powdered starch is prepared from "pearl starch" by a beating and bolting operation which removes hard, over-dried particles as well as protein matter left over from the tabling process.

"Lump starch" is obtained by treating powdered starch with steam and subjecting the steamed starch to high pressure. This gives a solid cylindrical mass of starch which is crushed and screened to size.

Food starches are purified by retabling or washing to meet the requirements of the Pure Food Laws.

Modified Starches

These starches may be regarded as "alkaline thick-boiling starches" and the so-called "soluble" or "thin-boiling" starches.

Alkali in the form of sodium hydrate or sodium carbonate is introduced into the process after tabling in such amount that the starch after drying shall show a slightly alkaline reaction.

"Thin-boiling" starches, improperly called "soluble starches" are prepared from ordinary properly purified starch by treatment with extremely

Corn Products Refining Co.

STARCH KILNS

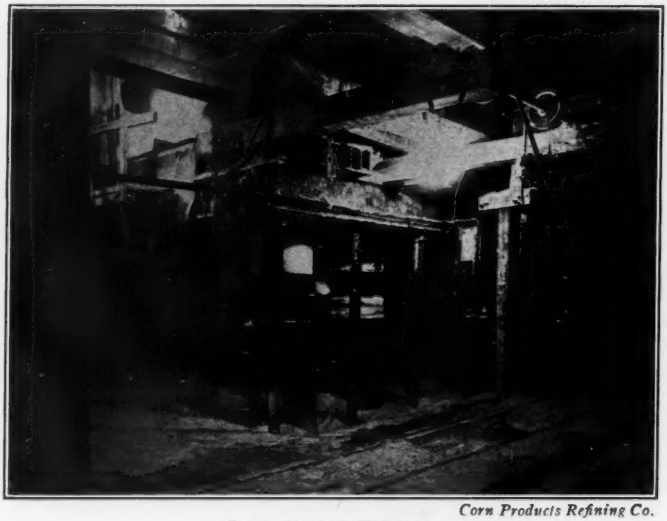
dilute acid, usually sulfuric, at a predetermined temperature and concentration until the desired modification has been effected. The acid is neutralized and the starch separated and dried in the usual manner either in "pearl" or "crystal" form.

Dextrines, British Gum and Gums

These products are produced from starch of proper purity and moisture content. The properties of the final products depend upon these factors as well as the conditions under which the conversion is made. The starch is charged into the "cooker," usually a covered cast iron kettle provided with a stirrer, and heated with a steam jacket, or otherwise. The conversion of the starch may be accomplished by heat alone; however, a small

amount of acid, usually nitric or hydrochloric, is used as a catalyst in connection with a high temperature. The amount of starch converted into water-soluble dextrine or gum, the color of the product, and the pasting properties depend essentially upon the time and temperature of conversion, the amount of moisture, and the amount and kind of acid used. Considerable skill and experience are required in adjusting the various factors and producing uniform products.

There is really no sharp distinction between dextrine and British Gum. The latter term was originally applied to products obtained by heat alone without the aid of acid. The term "starch gum" is used very broadly



Corn Products Refining Co.

LUMP STARCH PRESSES

and covers a great variety of products obtained by the partial or complete dextrinization of starch.

Corn Sirup and Corn Sugar

In order to make a good grade of corn sirup or corn sugar, a starch of high purity must be used. The process involved is that known to chemists as hydrolysis. The starch, suspended in water, is heated in an autoclave by means of steam in the presence of a small amount of a catalyst. In this country, the catalyst is practically without exception chemically pure hydrochloric acid, the same acid which performs the same function in the process of digestion of starch in the human body. The course and extent of the reaction in the autoclave depend upon time, temperature, pressure,

concentration, and the amount of the catalyst present. That is to say, if a partially converted product represented by corn sirup is desired, certain conditions are observed, while if the final product is to be in the form of crystallized sugar, the conversion is subject to a different control. In any case, the hydrolysis takes place very rapidly and must be carefully controlled. The resulting solutions are free from starch when removed from the converter. The carbohydrates are present as reducing sugars, glucose or dextrose, perhaps some maltose, and non-reducing carbohydrates, intermediate between starch and dextrose, which for the purpose

Corn Products Refining Co.

LUMP STARCH CURING ROOM

of analysis are usually spoken of as dextrines. In the manufacture of corn sirup, also commercially, but improperly, called glucose, the conversion is carried to a point where the sirup, when concentrated to its proper gravity, will contain approximately 33% reducing sugar, and about 40% non-reducing carbohydrates. In the case of the lower grades of solid sugar, the reaction is carried farther, while when pure crystallized glucose or dextrose is desired, the conversion is as thorough as is consistent with the practical methods of purification.

What happens when the conversion is ended is very simple. The acid solution is neutralized to the proper p_H value. The precipitate formed at this point is removed by mechanical filtration. A series of bone char

filtrations for decolorizing, and evaporation follow. In the case of corn sirup (commercial glucose) the concentration is stopped at the proper specific gravity.

Solid sugar is obtained from a properly converted and purified liquor by evaporation to the point where on cooling crystallization occurs. The concentrated solution is poured on a special crystallizing floor and after partial solidification, cut up in large rectangular slabs. These slabs are "cured" or "aged" to allow the fullest possible crystallization before delivery to the consumer. In this manner the various grades of crude corn sugar for industrial purposes are produced. The so-called "pressed sugars" are obtained from the sugar described by expelling the adhering mother liquor (hydrol) in hydraulic presses. Hydrol corresponds to the molasses produced in the cane sugar industry.

When sugar of the highest purity is desired, the converted and purified liquor is concentrated to the crystallizing point and crystallized out in crystallizers while in motion, under proper precautions for temperature control in order to obtain the hydrated crystal containing one molecule of water of crystallization, or the anhydrous crystal, and not a mixture of the two forms. The crystals, after centrifugation and washing, will be 99.5 to 99.8% pure dextrose on the dry basis. Naturally, a certain amount of hydrol is eventually obtained from this process of crystallization.

Sleepy Plants Jazzed Up by Chemical Treatments. Chemical alarm clocks to arouse sleepy seed potatoes and other plant cuttings from their lethargy and start them into growth weeks before their usual time were described to the National Academy of Sciences in session in Washington, recently, by Dr. Frank E. Denny of the Boyce Thompson Institute, Yonkers, N. Y.

"Potato tubers when freshly harvested are dormant, and will not sprout if planted at once under growing conditions, the rest period lasting from 1 to 4 months in different varieties of potatoes," said Dr. Denny. "This period of inactivity may be shortened by treating the tubers with various chemicals. The gain in time of sprouting is about 2 to 6 weeks, depending on the variety of potato and the stage of dormancy at the time the treatment is applied. Twigs of apple, grape, lilac, also have this dormant period in autumn, and the buds of these species can be forced into early growth by treatment with certain of these chemicals, the gain in time of budding or blooming ranging from one to nine weeks."

The chemicals used by Dr. Denny include thiocyanates, thiourea, and ethylene chlorohydrin.—*Science Service*

Insulin Crystallizer Honored by Chemists. Prof. J. J. Abel of the Johns Hopkins University will be awarded the highest honor in the gift of the American Chemical Society, the Willard Gibbs medal, at the second annual meeting of the Mid-West regional division which will be held in Chicago on May 27th and 28th. Prof. Abel has achieved international recognition for his researches on the hormones, or secretions of the ductless glands. His latest feat has been the production of insulin in so high a degree of purity that it forms solid crystals.—*Science Service*

ALLOY STEELS AND THEIR USES

WELTON J. CROOK, STANFORD UNIVERSITY, CALIFORNIA

This paper, with but minor changes, is the same as that given before the California Section of the American Chemical Society at the request of the Chairman. With nothing new or original intended, the paper was given in a popular manner and had for its purpose the presentation of a few well-known facts concerning some of the most used alloy steels.

Knowing that the chemist is notoriously inquisitive regarding matters of basal fact, it was felt necessary to include a very brief discussion of some of the theory of steel; without this theory, many of the interesting points concerning alloy steels would be lost.

What Is an "Alloy" Steel?

The first thing that engages the attention is "What is an alloy steel?" According to the definition adopted by the International Committee of the International Society for Testing Materials, alloy steels are "those which owe their properties chiefly to the presence of an element or elements other than carbon." Alloy steels must be sharply differentiated from "alloy treated" steels, which are plain carbon steels containing the usual amounts of silicon and manganese added, for curative purposes only, during the steel-making processes.

In ordinary carbon steels there is always found a certain percentage of the elements manganese and silicon. These elements are added, generally in the form of ferro-alloys, during the process of manufacture, *not* to obtain definite physical properties in the steel, but to overcome certain inherent steel defects. For instance, manganese is added to overcome the "red short" effects of sulfur, and silicon to remove oxygen and blow holes from castings. When added in these usually small proportions, these elements do not make carbon steel an alloy steel. The percentages usually added for these curative purposes are manganese up to 1%, and silicon up to 0.30%; more than these amounts would definitely change the physical properties of a carbon steel and make it an alloy steel. In some cases very small additions of alloys to a carbon steel will make an alloy steel; as little as 0.1% of vanadium makes a material change in a carbon steel, greatly increasing the resistance to fatigue failure.

The S. A. E. Classification

When the automobile industry began to assume important proportions, the Society of Automotive Engineers proposed a method of classification of the steels used in this industry. A "shorthand" method was also devised for designating these steels in a manner somewhat analogous to the chemist's symbols for the elements and compounds. This system of

classification, under the name of the "S. A. E. Specifications," has been adopted by nearly all other metal-using industries.

The classification part of the specification consists of a series of numerals, the first of which is a class number: 1 = plain carbon steels, 2 = plain nickel steels; and so on. The second numeral designates the amount of the predominating alloy: *e. g.*, 1–0 = plain carbon steel with no alloy; 2–3 = nickel steel containing 3% nickel; 3–2 = a chrome-nickel steel containing 2% nickel; and so on. Finally, the last two numerals in the series indicate the average carbon content. For example:

S. A. E. 1020 = plain carbon steel, no alloy, 0.20% carbon.
S. A. E. 2340 = nickel steel, 3% nickel, 0.40% carbon.
S. A. E. 3240 = chrome nickel steel, 2% nickel, 0.40% carbon.
The chrome content is not indicated but in this particular case it is about 1%.

The numerals indicating the various classes of steels are as follows: Carbon = 1; nickel = 2; chrome-nickel = 3; molybdenum = 4; chromium = 5; chrome-vanadium = 6; tungsten = 7; silico-manganese = 9. In the original S. A. E. classification, there was no steel designated by the numeral 8.

General Effects of Alloying Elements

The addition of alloys to steel costs money; the increased cost per ton of steel for alloy alone is about as follows: For each 0.1% vanadium, $8.00; for each 1% tungsten, $24.00; for each 1% chromium, $2.30; and for each 1% nickel, $8.00. Alloy steels are not used unless benefits can be derived from the extra expenditure; to obtain the most benefit the steels are heat treated, and alloy steels are generally used in a heat-treated state. It is well to note here the general effects of the various elements usually present in alloy steels.

Iron is, of course, the basis of all steel; most steels contain at least 90% of this element. Even in alloy steels the proportion of *carbon* presents an immediate basis of classification as to possible uses. In nearly all cases the addition of alloys simply modifies or intensifies the effects of the carbon present.

Sulfur is present in all steel, but generally only in small proportions. It causes the steel to break easily at a red heat, although its deleterious effect may be readily counteracted by the presence of manganese.

Phosphorus is an impurity; it has a strengthening effect greater than that of carbon for equal proportions, but it also has some very bad effects, such as producing brittleness in the cold state. Phosphorus is added intentionally only in steel to be made into sheets.

Oxygen destroys the strength of steel, and is eliminated by additions

of manganese, silicon, and aluminum (and other) alloys which have a greater affinity for oxygen at high temperature than has iron.

Manganese is a strength-giving element in steel; it eliminates oxygen and counteracts the bad effects of sulfur. In large proportions it gives a remarkable product—manganese steel.

Nickel gives strength and toughness. Carbon strengthens steel but makes it increasingly brittle, while nickel strengthens without increasing the brittleness.

Tungsten is the basis of "high speed" steels which will retain a cutting edge even at red heat. It is a hardener and heat resister.

Chromium resists shocks and hardens steel; in large quantities it makes steel resist corrosion.

Vanadium purifies steel by combining with dissolved oxygen; it resists fatigue.

Silicon is a hardener in steel; it eliminates oxygen and blowholes.

Titanium removes oxygen and nitrogen from steel and is known as a "scavenger."

Molybdenum is a hardener and heat resister.

Aluminum is added to steel for purposes of deoxidation; it is seldom added in sufficient quantity to form an alloy with iron.

Some Theoretical Considerations

Although the alloys of iron and carbon, known as steels, are capable of producing a range of physical properties unapproached by any other alloy series, especially when heat treated, the demands of modern engineering and manufacturing practice have required still more.

By the addition of one or more alloying elements there becomes available a much wider range of mechanical properties and a much greater susceptibility to heat treatment for definite qualities. It is, therefore, possible to develop more hardness or toughness or elasticity; most important of all, however, is the possibility of obtaining great tensile strength with but small loss of ductility. With plain carbon steels, as the strength rises, owing to increase in carbon, ductility rapidly falls.

The advantages made available by the use of alloys are not restricted to improvements in mechanical properties alone. Alloys improve steel for many and various uses which involve magnetic properties, resistance to corrosion, electrical resistance, low coefficient of expansion and hardness at red heat, etc.

It will be, of course, impossible to cover many of the alloy steels in this article or to delve very far into those which will be mentioned. It is proposed to note a couple of the most common, one of the most remarkable, and one which is, at present, receiving the most popular attention. But,

before proceeding farther, it is best to glance at the theory underlying alloy steels. Plain carbon steel, however, must be the starting point.

When properly prepared and viewed under the microscope a piece of slowly cooled medium carbon steel is not a homogeneous substance, but it consists of polyhedral grains, and shows alternate light and dark areas. The light areas are pure iron (ferrite), while the dark areas are of a platy structure called "pearlite." (See Fig. 1.) If the magnification is high enough, say 1000 ×, the plates of pearlite can be differentiated. Pearlite consists of alternate plates of ferrite (called pearlite ferrite) and cementite, which is the name given to iron carbide, Fe_3C. (See Figs. 2 and 3.)

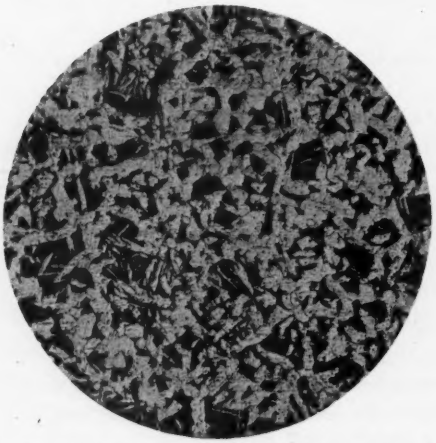


FIG. 1.—0.35% carbon steel. 100 ×. (Reduced about $^3/_{10}$ in printing.) 3.25 inch round bar. Hot bed cooled. Ferrite (light areas) and pearlite (dark areas).

It is immediately seen that the carbon in slowly cooled steel resides entirely in the cementite bands in the pearlite. It is found that the carbon content of pearlite is always 0.85%. This has been determined from the fact that steel which is entirely pearlitic has this carbon content.

In the slowly cooled state steel has three structural possibilities, depending on the carbon content: (*a*) ferrite and pearlite, (*b*) pearlite, (*c*) pearlite and cementite.

Referring to Fig. 4, it is quite evident that as the carbon content is increased in a low carbon steel, more and more pearlite is found, and less and less ferrite until, finally, the steel becomes completely pearlitic, when it contains 0.85% carbon. If the carbon content is raised over 0.85% free cementite appears in increasing amounts as the proportion of carbon becomes greater. Cementite is a chemical compound (Fe_3C) containing 6.67% carbon; this material is exceedingly hard and very brittle. Hard white cast iron is composed largely of cementite.

The element iron is capable of existing in three allotropic forms, alpha, beta, and gamma. There is much technical controversy over this matter at the present time. The presence of the beta form is challenged and another form called delta iron has been shown to exist. However, space will not allow discussion of this matter and for present purposes the alpha,

FIG. 2.—0.35% carbon steel. 1000 ×. (Reduced about 1/4 in printing.) Same specimen as shown in Fig. 1, but at higher magnification. Shows the laminated structure of pearlite.

FIG. 3.—0.90% carbon cast steel. 1000 ×. (Reduced about 3/10 in printing.) Annealed specimen. Steel is wholly pearlitic. Shows clearly the laminated structure of pearlite.

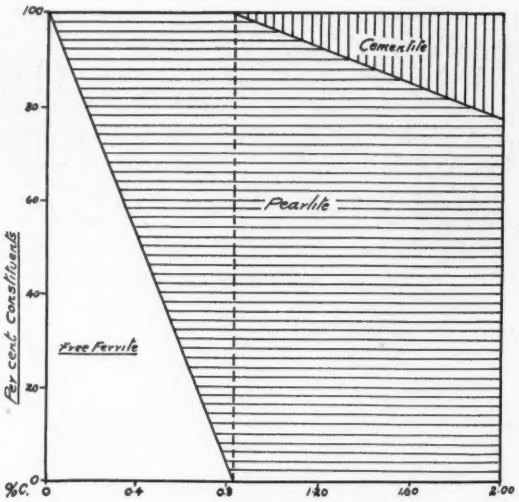


FIG. 4.—Structural composition of carbon steel. Slowly cooled state.

beta, and gamma forms will suffice. These modifications of iron are capable of stable existence under certain temperature conditions, and the solid solutions of carbon (or iron carbide, according to some authorities) in these various modifications of iron give the so-called temper structures in steel.

The temperatures at which alpha iron changes to the beta form and

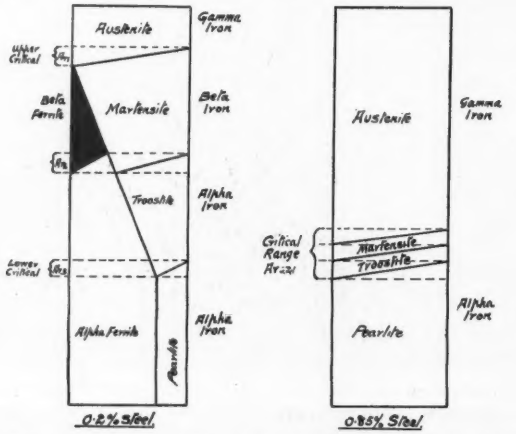


FIG. 5.—Structural changes in 0.2% C and 0.85% C steel.

the beta form to the gamma are called critical points, or critical temperatures. These critical points, or allotropic changes, manifest themselves by the absorption or evolution of heat.

Referring to Fig. 5, when a piece of normal (slowly cooled) low carbon steel is slowly heated from room temperature no change in structure takes place until a temperature of about 700°C. is reached; this temperature is called the lower critical point, or, by the English, the carbon change point. When this temperature is reached two things happen: (*a*) The conglomerate, pearlite, changes into solid solution (the cementite dissolves in the alpha ferrite); (*b*) free ferrite begins to be absorbed into the solid solution formed in (*a*).

If the temperature is still further raised, the second transformation point is reached; here the alpha solid solution changes into beta solid solution, giving the metaral martensite. At this point about one-half of the free ferrite has been absorbed. On reaching a temperature of about 830°C. it is found that (*a*) all the free ferrite has been absorbed and (*b*) the beta solid solution transforms to gamma solid solution, giving the metaral austenite, the solid solution of carbon in gamma iron. On cooling, the reverse order of changes takes place; quick cooling will retain the unstable forms, at room temperature, to a more or less degree, depending on the rate of cooling to which the steel is subjected.

Referring to Fig. 5, a steel containing 0.85% carbon is composed entirely of pearlite when in the slowly cooled condition. On heating, it is found to possess only one critical point, which is at about 700°C. In this critical range the steel transforms, within narrow temperature limits, through the various metarals to austenite. Having the lowest transformation range temperature, pearlitic steel is also known as eutectoid steel, a word coined from eutectic, which relates to alloys having the lowest *melting point* in a series. It should be noted that the word eutectoid has nothing to do with melting points, but relates to a steel having the lowest *transformation point* in the steel series.

Influence of Special Elements

The alloy metals added to carbon steel operate to produce one or more of the following changes:

1. To modify the effect of heat treatment by changing the critical range temperatures or the mode of their occurrence.
   (*a*) Entire suppression of critical range, giving an austenitic structure on slow cooling.
   (*b*) Change in the rate at which the critical changes occur, thereby giving extra hard martensitic steel, or sorbitic structure instead of pearlitic, on slow cooling.

(*c*) Suppression of damage by overheating, therefore allowing steel to be quenched from near its melting point.

2. To form compounds or solid solutions with carbon or with iron; for instance, nickel gives solid solutions, and chromium forms carbides, therefore nickel imparts toughness and chromium hardness.
3. To remove oxides and gases.
4. To change the form in which carbon occurs.

An alloy steel containing one additional element beside carbon and iron is called ternary alloy steel. If two influential alloy elements are present, beside carbon and iron, the steel is called a quaternary steel. If more than two additional alloy elements are present, a complex steel is the result.

Broadly speaking, elements like nickel and copper, which are retained in solid solution even after slow cooling, should increase strength, elastic limit, and hardness in alloy steel, while decreasing its ductility. In the case of nickel steel, the decrease in ductility, accompanying the increase in strength and hardness, is relatively slight; hence, the importance of nickel as an alloying element.

In regard to those elements forming carbides, which separate on slow cooling, it should be borne in mind that it is seldom desirable to use the steels in that condition, because the presence of the special elements as free carbides induces great brittleness. The value of the so-called carbide steels will greatly depend on:

(*a*) The readiness with which the carbides may be taken into solution on heating to a high temperature.

(*b*) Having once been taken into solid solution, the readiness with which they may be retained in that state on cooling at a suitable speed.

(*c*) The resistance of the steel to tempering after the carbides have been taken into solid solution.

To sum up, the structural constituents which may be retained on *slow cooling* in many alloy steels can only be retained by very rapidly cooling plain carbon steels through the critical ranges.

Characteristics and Properties of Some Alloy Steels

A. Simple Nickel Steel

Nickel steel was chronologically the fourth alloy steel to be introduced and has been in use for the last thirty-five years. The standard grade contains 3.5% nickel with various carbon ranges. The commonest nickel steel is S. A. E. 2320. This grade is used for case hardening and it gives a very tough core.

This standard grade affords suitable properties for nearly all structural purposes and has been used for bridges to some extent. Gun forgings, machine parts, engine and automobile parts are very generally made of this steel, especially where the service demanded is too severe for a simple carbon steel. For use in guns and automobile parts the steel is used in the heat-treated state. One per cent of nickel added to ordinary carbon steel raises the ultimate strength about 6000 to 8000 pounds per square inch with little loss in ductility. Some idea of the physical properties of this steel may be gained from the following table:

S. A. E. 2320 steel	As rolled	Heat treated
Ultimate strength, lb. per sq. in.	95,000	177,000
Elastic limit, lb. per sq. in.	56,000	135,000
Elongation, %	21.2	20

In this particular case, the heat treatment consisted in quenching from above the critical range and then reheating to 538°C. It should be noted that although the heat treatment very greatly increased the ultimate strength and elastic limit of the steel, yet the ductility, as measured by elongation, was decreased very little. This is an outstanding characteristic of nickel steel.

B. Chrome-Nickel Steel

The chrome-nickel steel series represents the most important of the structural alloy steels. These steels are seldom used except in the heat-treated condition; by suitable treatment, elastic limits from 40,000 pounds to 250,000 pounds per square inch can be obtained, accompanied by a high degree of ductility. In this regard, chrome-nickel steel is scarcely exceeded by any other. In the S. A. E. series (Nos. 3100, 3200, 3300, and 3400) the chromium content ranges from 0.5% to about 1.75%, while the nickel varies from 1.00 to 3.25%. In these series the carbon is up to 0.55%.

The properties rendering these steels of high commercial value are very great strength and elastic limit and hardness combined with high ductility; all of these properties can be obtained by proper heat treatment. This steel is used for automobile shafts and gears, and also for case-hardening.

In case-hardening the elements which form solid solutions, as does nickel, tend to resist the penetration of carbon, while the elements which form carbides, like chromium, accelerate the casing operation. When chrome-nickel steels are used for case-hardening purposes the retarding effect of the presence of nickel is counteracted by the presence of the chromium.

S. A. E. 3140 steel	Quenched and reheated to 205°C.	
C = 0.40%	Ultimate strength, lb. per sq. in.	230,000
Ni = 1.50%	Elastic limit, lb. per sq. in.	200,000
Cr = 0.50%	Elongation	30%
	Brinell hardness	170

C. Manganese Steel

Manganese steel is the commercial name of a variety of iron containing from 11 to 14% manganese and from 1.00 to 1.30% carbon. This is a standard composition and the alloy is one of remarkable properties. Perhaps the most extraordinary of these properties is a lack of magnetic permeability and susceptibility. This is caused by the inertia, or hysteresis, effect of manganese, which tends to prevent allotropic transformations and to retain the steel in the gamma state, even on rather slow cooling. This phenomenon is strikingly illustrated by the fact that rapid quenching in cold water actually *softens* manganese steel; this is the opposite in carbon steels. The apparent anomaly is explained by the fact that quick quenching retains austenite in manganese steel; this is softer than martensite, which is the metaral retained in fully hardened carbon steels. The "merit number" of manganese steel, obtained by multiplying ultimate strength by the percentage elongation, is the greatest of any known steel or substance, being 7,000,000 against 2,900,000 for heat-treated nickel steel.

Manganese steel cannot be machined; it must be cast and ground to shape. It may, however, be hot rolled. Mechanical work in the cold makes the metal very tough. Manganese steel is used for crusher parts, safes and vaults, dredger bucket lips, steam shovel dipper teeth, railroad crossings and switches, the working plates of lifting magnets, and soldier helmets.

D. High-Speed Steels

High-speed tool steels have, in the past twenty-five years, worked a remarkable revolution in the machine shop business of the world. They afford largely increased outputs and lower costs. The revolutionary feature of these steels is that they maintain a hard, strong cutting edge while heated to a temperature far above that which would at once destroy the cutting ability of a simple carbon steel tool. Because of this property, a high-speed tool can cut at speeds from three to five times as great as that practical with other tools, and, as a result of the friction of the chips on the tool, it may be red hot. The property of "red hardness" may be imparted to steels of suitable composition by the addition of proper proportions of chromium and tungsten, combined with a special heat treatment. The average composition of high-speed tool steels is about as follows:

	%
Carbon	0.65
Manganese	0.20
Chromium	4.00
Tungsten	17.00
Vanadium	0.50

In some cases 4.0% of cobalt is also added; the steels containing cobalt are known as "super" steels and command a higher price, since superior properties are claimed for them.

The heat treatment given to high-speed steels for the commoner uses, such as those for lathe and planer tools, has generally been simplified to heating to incipient fusion and oil-quenching. At temperatures higher than 1200°C. (2192°F.) a double carbide of chromium and tungsten is formed and this persists largely, even when the steel is cooled slowly, and it persists even more when the steel is quenched. This double carbide of chromium and tungsten imparts a high degree of hardness to the steel and is stable at all temperatures up to 550°C., or even higher. At 550°C. steel is at a dull red heat.

E. Stainless Steel

The production of stainless, or rust-resisting steels, during the last few years, has marked a distinct advance in the metallurgical art. In the past, the tendency to rust has been accepted as an inherent, characteristic property of the element iron, a property which could never be overcome.

Gradual corrosion of iron and steel entails an enormous expense, when considered in the aggregate; Sir Robert Hadfield estimated it at well over two billion dollars annually. Therefore, it is not surprising that many efforts have been made to minimize or overcome the trouble. In some cases, alloys, such as those of copper, have been used to replace steel, but, although these alloys may be resistant to rust, their physical properties are generally otherwise unsuitable.

The possibility of retarding the corrosion of steel by the addition of other metals has long been recognized, and some alloy steels with a marked resistance have been developed. Probably the best known of these is one containing 25 to 35% nickel; this steel is by no means uncorrodible, but it does resist corrosion to a much greater degree than does ordinary steel. One of its disadvantages is that it cannot be hardened by quenching.

Another material which has great rust-resisting properties is "Duriron," a cast iron containing from 12 to 14% silicon; this iron is very brittle and hard, properties which limit its usefulness.

Stainless steel was first introduced to the public in 1914 in the form of table cutlery. Stainless steels are not restricted to this use, but form a whole series of steels with a wide range of properties corresponding to the various "tempers" of carbon steels. All members of the series have the distinguishing property of great resistance to corrosion, conferred primarily by the presence of a considerable proportion of chromium.

As in carbon steels, the variations in mechanical properties are brought about by a varying carbon content. The presence of the large amount

of chromium, necessary to produce rust resistance, imparts a number of characteristics to the properties of the metal. In high chromium steels the pearlite constituent contains less than 0.85% carbon, differing in this respect from carbon steels. The transformation points are also raised considerably and the steels have the power of air-hardening on cooling from above the critical range.

It is evident that the presence of sufficient chromium in solid solution in iron reduces the solubility of this metal in water practically to zero. It is not known exactly why this is so, but there is a probability that it is caused by "passivity." Chromium metal itself exhibits much stronger passivity effects than iron does, and also exhibits the phenomenon under the influence of some reagents which do not affect iron.

When chromium is added to steel in small quantities, it at first appears to be associated entirely with the carbon in the steel as chromium iron carbide. If the amount of chromium is increased, part of it goes into solid solution in the iron, the amount which is dissolved depending on the carbon present in the steel.

The corrosion resistance effect appears to be associated only with the solid solution phase, and it is found that the greatest resistance to corrosion will be obtained when the steel is quenched from a temperature at which the chromium carbide has all gone into solid solution. When normal chrome steel is quenched from a temperature of 900°C. it becomes insoluble in water, vinegar, or fruit juices.

Stainless steel is only rust resisting when in the quenched condition, and it is by no means resistant to all reagents. Hydrochloric acid and most chlorides will attack it with vigor, but nitric acid, ammonia, and alkalies have no effect.

The basis of stainless steel is, of course, a high chromium content, ranging from about 11 to 13%. Most of the analyses show a small nickel content, varying from 0.3 to 0.5%; the other constituents are as in ordinary carbon steels. The carbon content is variable, depending on the strength required. Cutlery contains low carbon, from 0.02 to 0.10%. Stainless steel is also used for machine parts, engine valves, etc.

The physical properties of a specimen containing 0.07% carbon, 11.7% chromium, and 0.57% nickel were as follows:

Water hardened from 930°C.

Tensile strength, lb. per sq. inch	164,000
Elongation in 2", per cent	13.5
Brinell hardness	340

When a water-hardened specimen was reheated at 750°C. the following properties were obtained.

Tensile strength, lb. per sq. inch	81,500
Elastic limit, lb. per sq. inch	62,500
Elongation in 2″, per cent	31
Brinell hardness	179

It is seen that this steel has a large range of properties, although the carbon content is very low.

Swedes to Make Sugar from Wood. A new process for making sugar out of sawdust was described by Prof. Erik Haegglund of Abo at the coal and wood chemistry conference recently held in Stockholm where he reported that at Geneva, where the process is being tried on a commercial scale, from 65 to 70 per cent of the sawdust by weight can be converted into sugar.

For Sweden, where forestry is one of the dominating industries and where most of the sugar has to be imported, the method is likely to become of the greatest importance. Several hundred thousand tons of "wood sugar" can be produced annually from easily accessible raw materials, it was stated.—*Science Service*

Nutrition Expert Finds Iron Blood Can Use. Spinach and prunes have never yet had a serious rival in their healthful function of building up the body's supply of iron but recent research may result in putting more efficacious "iron pills" on the market to help people suffering from anemia.

Dr. Helen S. Mitchell, director of nutrition research at the Battle Creek Sanitarium, has been investigating many inorganic iron compounds to find which are best utilized by the body to increase the iron in the blood. At the recent American Society of Pharmacology meeting at Rochester, N. Y., she reported that iron combined with iodine would cause only a temporary rise in the haemoglobin content of the blood of anemic rats. Certain other compounds of iron, however, Dr. Mitchell stated, were found to give better results than those in current use for this purpose.

For the benefit of pharmacists and physicians she has classified the list of iron compounds that can be used medicinally into good, fair and poor, according to the ease with which the iron can be taken up by the blood.—*Science Service*

Stream-Polluting Waste Finds Industrial Uses. America's waterways will be kept unpolluted, the fish in these streams will receive a new lease of life and a hitherto undeveloped line of by-products will be gained from the waste of the country's pulp paper mills, if the Izaak Walton League of America has its way.

The pulp paper mills, according to the league, drop into the country's rivers hundreds of tons a day of solid matter in waste sulfite liquor. This is wood material in an objectionable form that kills fish and plant life in the streams.

In this country there are two million tons of sulfite pulp made a year. For every ton made there is more than a ton of waste. So two million tons of poisonous material are being thrown into the rivers every year. This material might be made into by-products, as yet almost unrealized. In Europe twenty-seven plants are making alcohol out of the waste sulfite liquor. And there are other uses. It can be made into cheap adhesive; it can be mixed with macadam to the advantage of roadbeds; it can be spread on dirt roads to lay the dust.

Some American mills are already recognizing the value of these by-products. A mill in Mechanicsville, N. Y., is making alcohol from the waste; another in York, Pa., is making an adhesive from it. A mill in Cummington, W. Va., is evaporating it and selling it at a profit to mix with macadam, to lay the dust, and to use as a cheap adhesive.—*Science Service*

CHLORINE RESEARCH

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Chlorine, first prepared by Scheele in 1774, has long held the attention of scientists and is the best known of the halogens. Its literature is very large and in places somewhat polemical. This is a healthy condition and fruitful for research, both pure and applied. The difficult nature of the element makes very skilful manipulation essential. In a loosely bound form as bleaching powder, it has been known to commerce since 1799, and as a liquefied gas since 1888. Its uses, especially in the gaseous state when released from liquid chlorine containers, have given rise to much applied research in recent times, and its peculiar elemental properties, still far from being completely known, claim the attention of workers in pure research both here and abroad. Applied research is always under way, but for commercial reasons is often not public until revealed to scientific bodies or technical journals, or until patents show more or less the nature of the application.

The following record will indicate the widespread interest in chlorine and the variety of work either under way or very recently completed. The bibliographical notes are not intended to be comprehensive of the literature of chlorine, but are for reference to research problems.

Anodes.—Among the numerous problems in chlorine plants is the life of the anodes of the electrolytic cells. About 1900 Acheson invented artificial graphite and from that time onwards, anodes have been almost entirely made of this excellent material. It has high electrical conductivity, is easily shaped and connected, and disintegrates slowly. Its slight porosity, however, aids disintegration and many experiments have been made to coat the anode or otherwise reduce the porosity.[1] The use of material other than graphite is frequently investigated.[2] Such research is quite exacting and the workers require a knowledge of metallurgy, chemistry, and physics of no mean order.

Cellulose.—In the preparation of wood pulps for paper making,[3] there have been at least three modern researches in which chlorine played a part. The first is high density bleaching which may be defined as the bleaching of the maximum amount of cellulose in a given unit of pulp.

[1] Umberto Pomilio, "Artificial Graphite Electrodes, Protection and Improvement of the Same for Use in the Electrolysis of Alkaline Chlorides," a communication before 4th Congress of Industrial Chemistry, Bordeaux, June, 1924, published in *Giorn. chim. ind. applicata*, **7**, 63–77 (1925).

[2] Colin G. Fink and Li Chi Pan, "Insoluble Anodes for the Electrolysis of Brine," a paper before Forty-ninth General Meeting of the American Electrochemical Society, Chicago, Ill., April 22, 23, and 24, 1926.

[3] Bartholow, "History of the Chlorination Process for Pulp," *Paper Trade J.*, Mar. 5, **1926**, pp. 57–8.

This is largely a matter of mechanical engineering and pulps containing as much as fifteen per cent of cellulose can now be bleached readily with chlorine.[4] The second is the disintegration of cellulosic substances with chlorine largely replacing prolonged caustic soda boils, and is based on the classic researches of Cross and Bevan. There has been considerable success with esparto grass,[5] and practical processes are in operation, but with wood pulps the research is still proceeding. The difficulty appears to lie in the fact that caustic soda tears down the complex substances encrusting soft wood celluloses and forms soluble substances, whereas chlorine forms complex undetermined compounds with varying solubilities and considerable coloring power. The third is to bleach kraft pulp without great loss of strength to the finished paper. As strength is the outstanding quality of kraft papers, and as wood pulp white papers have little strength, a white or nearly white kraft paper would quickly have commercial importance. In Louisiana and Mississippi a short leaf pine suitable for kraft pulp can be grown in eighteen years, and as far north as the tidewater counties of Virginia the same tree attains a pulp size in thirty years. Moreover there are at present large growths of pines, other than long leaf, throughout the Southern States available for pulp and very large kraft manufactories are based on them. It follows that the commercial incentive is strong, and successful research would open large areas to successful tree cultivation, diversify Southern manufactures, aid the rosin industry, and in effect increase the fast dwindling non-resinous softwood pulp supply of the United States of America. The problem is now being attacked by the study of the preliminary cooking operation, *i. e.*, the resolution of the resinous wood chips to a pulp. If it can be so cooked that the coloring matters can be made susceptible to the bleaching action of chlorine without destroying at the same time the valuable cohesive properties of the non-cellulosic substances which now remain in kraft pulp and give it great strength the problem is solved It is an interesting and extremely difficult matter.

Chlorination of Natural Gases.—The chlorination of constituents of natural gases is growing steadily in commercial importance. The ethylene products include ethylene chlorohydrin and ethylene glycol. The first named has recently been found to have a very stimulating effect on the growth of the potato tuber;[6] the second makes an excellent "anti-freeze" mixture,[7] for the radiators of motor cars, replaces glycerin in the manufacture of a dynamite which has the valuable commercial property of

[4] Merrill, "High Density Bleaching," *Paper Trade J.*, Feb. 25, **1926,** pp. 161–2.

[5] "Chlorine Process" (references), *Paper Trade J.*, Nov. 6, **1924,** pp. 55–6.

[6] Coulter, "Boyce Thompson Institute for Plant Research," *Sci. Mo.*, **23,** 97–106 (Aug., 1926).

[7] Fuller, "Ethylene Glycol, Its Properties and Uses," *Ind. Eng. Chem.*, **16,** 624–6 (June, 1924).

not freezing except at very low temperatures, and its monoethyl ether[8] is an odorless and valuable solvent for cellulose esters used in the manufacture of lacquers. The large scale manufacture of ethylene chlorohydrin or ethylene dichloride and their conversion to ethylene glycol has only been possible after long and arduous applied research in a field where explosion risks and corrosion troubles are common. This work still continues and contains problems to warm the heart of the research worker.

Chloropicrin.—This substance, first prepared in 1848, was little more than a laboratory curiosity until the World War when it was used as a chemical warfare gas. Its use as an insecticide, when emulsified in soapy water, was proposed in 1907, and in 1917 this use was partly investigated. In 1919 Bertrand in France began his investigations which continue to the present time.[9] Much work remains to be done, including studies of its value as a soil fumigant.

Coal Tar.—In the coal-tar industries such as the manufacture of dyes and drugs, chlorine has numerous uses and would have still more if chlorine in the elemental state did not give rise to corrosion problems. If chlorine in a combined state is used, this difficulty may be at once removed, but, in the best practice, the tendency is to avoid the use of any compound substance which is neither a promoter of the reaction nor a constituent of the end product. The outstanding pure and applied chlorine research in this field for the past thirty years has been in the chlorination products of benzene and toluene. This work still continues and is widespread, and includes such matters as the control of the production of dichlorobenzenes when only monochlorobenzenes are wanted; the control of the production of the three isomers of dichlorobenzene and their subsequent separation from one another; control of the reactions in the chlorination of toluene where the chlorine can enter either the ring or side chain, or both; studies in the replacement of the chlorine by hydroxyl or other groups; and studies of the Friedel-Crafts reaction,[10,11] employing anhydrous aluminum chloride.

Corrosion by Hydrochloric Acid and Wet Chlorine Gas.—At ordinary pressure and temperature both hydrochloric acid and wet chlorine gas readily attack almost all available substances except glass, chemical stone-

[8] Davidson, "The Glycol Ethers and Their Use in the Lacquer Industry," *Ind. Eng. Chem.*, **18**, 669–75 (July, 1926).

[9] Roark, "Chloropicrin," Chemistry Bibliography, No. 1, U. S. Dept. of Agriculture, Washington, D. C., **1926.**

[10] Bate, "The Synthesis of Benzene Derivatives," Ernest Benn, Ltd., London, **1926;** and Conroy, "Use of Chlorine in the Organic Chemical Industry," *Proc. Am. Electrochem. Soc.*, April, **1926.**

[11] Phillips, "Use of Aluminum Chloride in the Dye Industry," *Chem. & Met. Eng.*, **33** (March, 1926).

ware, and rubber. This fact retards the use of both acid and gas, and lowers the practical value of much of the applied science research. The industries making and using chlorine and hydrochloric acid are always on the lookout for some alloy or substance or method which will solve this difficulty. The problem has never been dealt with in a systematic and purely scientific way, and is so far but a part of the phenomena of corrosion. It has been suggested that corrosion could be polarized by the introduction of a suitable anode and again that the corrosion could be largely eliminated by the introduction of a catalyst.

Cracking Petroleum for Gasoline.—Anhydrous aluminum chloride forms addition compounds with petroleum bodies, and these bodies, if heated in an excess of gas oil, yield gasoline.[12] The aluminum chloride is gradually consumed in side reactions and in complex and somewhat stable compounds. As a successful commercial process must, for economic reasons, provide for the substantial recovery of the aluminum chloride, and that condition is not yet attained, much applied research is being given to this matter.

Dextrose.—The American manufacture of dextrose, commonly known as "corn sugar," by the hydrolysis of corn starch in the presence of hydrochloric acid has in recent years attained great proportions and has stimulated research in the nature of the reaction.[13,14]

Hypochlorites.—The technical literature of sodium and calcium hypochlorites is large, and shows that research workers have lavished time and thought on this chemical will-o'-the-wisp. Much of the work is vitiated by the instability of the substance. The chemical history of these substances,[15] for over a hundred years has been painstakingly set down and will not be repeated here. In commerce, sodium hypochlorite has many names, strengths, and formulas. In Germany several anhydrous forms are known. To date, no absolutely stable form of any kind is to be had, and as a result efforts are generally being made to provide a better solution or tablet. Much of this work is not strictly scientific, but can be classified as the "cut and try" method, and many of the present day uses of sodium hypochlorite have been derived by the same means. The wartime use of various solutions as antiseptics and sterilizers greatly stimulated interest in this field and in some cases led to extravagant claims

[12] Burgess, "Chlorine in the Petroleum Industry," *Proc. Am. Electrochem. Soc.*, April, 1926.

[13] Arnold, "Manufacture of Refined Corn Sugar," *Chem. & Met. Eng.*, 33, 347–9 (June, 1926).

[14] Walton, "Starches, 1811–1925—Acid Hydrolysis," *Bull. N. Y. Pub. Library*, Jan., 1927. (138 bibliographical notes.)

[15] Ruth M. Davis and H. A. Langenhan, "Hypochlorite Solutions," *J. Am. Pharm. Assoc.*, Jan., 1924; Feb., 1924; Mar., 1924; April, 1924; and May, 1924.

for its virtues. For instance, it has recently been claimed that a sealed glass tube of sodium hypochlorite solution can be placed in tap water and sterilize the water with unknown but potent emanations through the glass of the tube. At the present time applied research continues in the field of antiseptics and sterilizers,[16] in preparing anhydrous forms, and in the study of the action of ammonia and of amino groups on sodium hypochlorite. Recently it has been claimed that hypochlorites have the property of altering the viscosity of nitrocellulose.[17] This may be of very great importance in explosive and lacquer manufactures and offers interesting research problems of a high order.

Light Scattering in Liquid and Gaseous Chlorine.—It has long been known that chlorine gas is activated by light, and it follows, therefore, that a study of this property might lead to a better understanding of the nature of chlorine gas in some of its applications, and what is of greater scientific importance, the distribution of the chlorine atoms or molecules. Less has been done with the light activation of liquid chlorine, due to the well-known difficulties in handling the substance. Recently two investigators have carried out interesting experiments in this field with both gaseous and liquid chlorine using white light, and it is probable that they will continue the experiments using parts of the spectrum.[18]

Orthodichlorobenzene.—This substance has long been a waste product in the manufacture of paradichlorobenzene. The para isomer, alone, has an interesting use as an insecticide for the American peach borer.[19] Commercial orthodichlorobenzene contains varying amounts of uncrystallized paradichlorobenzene and traces of metadichlorobenzene. Studies have been made at various times to obtain the theoretical yields of the para isomer, but the only known feasible process, freezing out the para, is still in use and leaves much to be desired. Orthodichlorobenzene is a fair solvent of some greasy substances; it has recently been found to be a valuable insecticide for the psychoda fly at sewage plants; and still more recently has been found to be available as a raw material for the production of the dyestuff intermediate chloroanthraquinone, a step in the production of

[16] William B. Sharp, M.D., and Harry M. Little, M.D., Dept. of Bacteriology, and Preventive Medicine, Univ. of Texas, Galveston, Texas, "Chlorination of Soda Fountain Glassware;" W. A. Hadfield, Chief Chemist, and J. W. Yates, Consultant in Sanitation, General Laboratories, Madison, Wis., "Chemical Sterilization of Eating and Drinking Utensils in Restaurants and Other Public Places."

[17] U. S. Patent 1,598,972, Sept. 7, 1926.

[18] Martin and Cole, "The Scattering of Light in Gaseous and Liquid Chlorine," *Proc. Am. Electrochem. Soc.*, April, 1926.

[19] "The Peach Borer," *Farmers' Bulletin No.* 1246, U. S. Dept. of Agriculture.

[20] Phillips, "Preparation of Alizarin from Phthalic Anhydride and *o*-Dichlorobenzene," read before Dye Section of American Chemical Society, Philadelphia Meeting, September, 1926.

synthetic alizarin.[20] Further possible uses are being studied, including its insecticidal value on the Japanese beetle, sugar cane pests, and various insects in the Philippines.

Photochemical Reactions between Hydrogen and Chlorine.—For many years both chemists and physicists have been investigating at intervals the nature of the reactions of chlorine to hydrogen in the presence and the absence of heat, light, moisture, and pressure.[21] These studies are highly interesting even though still in the polemic stage, and throw some light on the baffling nature of chlorine. The most recent contribution,[22] to the growing literature indicates the wide interest in the subject, the trend of investigations, and the atomic versus the molecular theory of the state of chlorine when activated by light.

Rosin.—Closely allied to the bleaching of kraft pulp is the bleaching of American rosin. From the commercial standpoint the clearer and lighter the rosin, the better price it commands. For many years efforts have been made to determine the constitution of this complex pathologic substance. Numerous attempts have been made to bleach it not only with chlorine and chlorine compounds, but with many other substances. Chemists are not yet in agreement as to its constitution, and none of this research has resulted in any great improvement in the color of American rosin. The French grades of rosin are superior in color because of the great care exercised in gathering the turpentine crudes, in their treatment, and in the subsequent sun bleaching of the rosin in shallow pans.

Sewage.—The largest single applied research problem in the chlorine field is now under way, under one control, in North America. At various places in Canada and the United States of America more or less detailed studies,[23] in the application of chlorine, bleaching powder, and chlorine compounds to sewage disposal are under way. Investigation independent of this is under way in Germany.[24] These studies range from laboratory experiments to the complete chlorination of the sewage of a city having 9,000,000 gallons of sewage per twenty-four hour day.

In order to understand the nature and value of these experiments, it

[21] Mellor, "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," Vol. II, pp. 152–6.

[22] Marshall, "The Photochemical Reaction between Hydrogen and Chlorine," *Proc. Am. Electrochem. Soc.*, April, 1926.

[23] M. M. Cohn, "Effect of Chlorination on Trickling Sewage Filters," with Editorial and Discussion, *Eng. News-Rec.*, June 10, June 24, July 8, August 26 and Sept. 9, 1926; Walter D. Tiedeman, "Ortho-Tolidine and Starch-Iodide Tests for Free Chlorine in Chlorinated Sewage Tank Effluents," *J. Am. Water Works Assoc.*, 15, No. 4 (April, 1926).

[24] Dr. H. Bach, Chief Chemist, Emscher Corporation, Essen, Germany, "Chlorine Gas in the Technic of Sewage Purification," *Technisches Gemeindeblatt*, 28, 159–67 (1925).

is necessary to refer very briefly to the present methods of sewage disposal. From the earliest time, the simplest method of disposal, other than by burial, land irrigation, or land fertilizing, has been to turn the sewage into the nearest available stream. In this case the natural processes such as dilution, oxidation and flow seaward take care of it provided that there is an ample stream. However, streams do not increase in size, but populations do, and many North American waters are already overburdened with sewage. The next simplest method is to screen the sewage, more or less, and allow the watery parts to reach some stream. Then come the methods employing chemical precipitation, with the watery parts again discharged into streams, and the precipitated matter either put on land fills or dumped well out at sea. Beyond these methods are various biological ones, all dependent on the action of anaerobic, facultative and aerobic bacteria and conducted almost entirely in the open air and in tanks, beds, and filters of large size. All modern sewage systems are designed to relieve sewage of its soluble, insoluble, and suspended matters and return the liquid parts to a waterway with due regard to the available dilution power of the latter. These bacteria of many species are normally present in sewage and multiply amazingly unless inhibited by industrial and trade wastes in the sewage or by low temperatures that are persistent or by overloading the plant capacity. As the biologist is to date unable to determine which bacteria are best suited, and thereupon engage in selective killing or culture, these systems are all uncertain in effectiveness at times. In other words it is impossible to control sewage bacteria in the ways employed in the fermentation industries such as those of ethyl alcohol and butyl alcohol.

It has long been known that chlorine is an extremely active sewage disinfectant and bactericide and therefore chlorination of drinking water is practiced on a very large scale and with scientific effectiveness. The sewage problem from the chlorine point of view is a highly complicated water problem. The intent of the present research is to determine all possible and proper uses of chlorine in sewage disposal.

The research has been in operation for about seventeen months, and in that period nearly all previous work has been checked and verified by these experiments and new and valuable data obtained. For instance, these studies show that a relatively small cumulative chlorine dosage of the raw sewage prior to any treatment delays septicity and thus prevents the later formation of hydrogen sulfide; that chlorine does not materially impair the efficiency of the biological digestion; that the troublesome insect life, such as the psychoda fly, at sprinkling filters can be very materially reduced; that the physical clogging of certain processes brought about by biological growths is prevented by chlorination; that sewage can be made pathologically sterile at any step in the biological processes;

that the biological oxygen demand and the disease-carrying bacteria in the final effluent can be controlled by chlorination and the control measured by the well-known "residual chlorine method" (ortho-tolidine test) similar to that used in the purification of potable water. Every kind of sewage disposal is to be studied in relation to chlorination, as it seems evident that chlorine not only has a place in existing sewage disposal methods, but with careful research can be used to bridge the gap now existing between simple methods and the highly complicated biological ones. The scientific and practical importance of this work is very great. Sewage is a nation-wide menace, and its proper disposal is expensive, complicated, and generally unpleasant, but a vital necessity.

Starch.—It was recently found through accident that the sodium salt of paratoluene sulfochloroamide has the power of making water-insoluble starches, such as potato and corn, soluble in varying degree. This has stimulated both pure and applied research and the solubilizing of starch with this chlorine compound has very recently become of commercial importance. The exact nature of the reactions is still unknown and offers an intricate problem in that obscure field—the chemistry of starch and starch compounds.

Therapeutics.—For nearly one hundred years the therapeutic use of chlorine gas for affections of the respiratory tract has been known to the medical profession and, at various times within that period, case histories have been published. During the World War it was observed that workers at American chlorine plants were practically immune to influenza, colds, etc., and long before the War the same phenomenon had been observed at English chlorine plants.[25] These observations[26] led the United States Chemical Warfare Service to establish clinics and study the subject in its medical aspects. This, in turn, led to studies elsewhere, and to polemical writings, and to the establishment of other clinics. The medical research, based on case histories, continues actively, and while largely outside the immediate interests of the inorganic chemist, is of great interest to the biochemist and may presently yield some data of wide application in the use of chlorine as a sterilizing agent.

[25] Twenty-eighth Annual Report on Alkali, etc., Works (English), **1891**, pp. 21–3.

[26] Edward B. Vedder, M.D., Lt.-Col., Medical Corps, U. S. Army, and Harold Sawyer, M.D., Captain, Medical Corps, U. S. Army, Edgewood Arsenal, Md., "Chlorine as a Therapeutic Agent in Certain Respiratory Diseases," *J. Am. Med. Assoc.*, **82**, 764–6 (Mar. 8, 1924); M. F. Jones, M.D., and Chas. Garofalo, M.D., "Further Statistics on Chlorine Gas as a Treatment for Respiratory Diseases," *Archives of Otolaryngology*, **1**, 58–63 (Jan., 1925); Lt.-Colonel H. L. Gilchrist, Medical Corps, U. S. A., Chief Medical Research Division, Chemical Warfare Service, "Development and Possibilities of Chlorine Gas Treatment in Respiratory Diseases," April 26, 1926, advance copy of paper for *Trans. Am. Electrochem. Soc.*, Chicago, Ill., April 22, 23, 24, **1926**.

HIGH VACUA AND HIGH FREQUENCY

GUY BARTLETT, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

In a way, we do not know what a real vacuum is, for, strive as they may, scientists have not been able to reach the point where they know that a cubic inch of the evacuated space contains fewer than 40,000,000,000 molecules of gas, some speeding freely through the space and some clinging tenaciously to the sides of the container. Such a vacuum is far more nearly perfect than the one to be found in a thermos bottle; it is the one which makes possible the modern high power radio tube, the X-ray tube, and the more recent cathode-ray tube. And the density of a gas in the best vacuum that man has attained is possibly higher than are the densities of many of the glowing stars in the sky, millions of miles in diameter and countless millions of miles away. Astronomers tell us that some of the stars are fiery masses of almost nothing.

To say that each cubic inch of the best vacuum yet attained by scientists includes 40,000,000,000 gas molecules makes it sound as though not much progress has been made in obtaining emptiness, but such is far from the case. The fact is that success is 99.99999999 per cent achieved; with the equipment available today it is possible to remove from an enclosed space all except one in ten billion gas molecules.

A few mental gymnastics: At zero degree Centigrade and 760 millimeters of mercury (average atmospheric pressure), each cubic inch of gas contains 4.435872×10^{20} molecules of gas; or, if it is desired to string the figures out, there are about 443,587,200,000,000,000,000 molecules of gas per cubic inch. This is under atmospheric conditions that are average. Plenty, it may be said; but the molecules are hardly in a tight squeeze. It is easy to increase the quantity a hundred-fold or more by applying a corresponding increase in pressure.

With the Langmuir high-vacuum pump it is possible to reduce the pressure in an evacuated space to 10^{-4} bar, or $^1/_{10000}$th of a bar. A bar is equal to a millionth of an atmosphere, so the Langmuir pump reduces the pressure to a ten-billionth of an atmosphere.

A few more figures: The number of molecules left in each cubic inch after the vacuum pump has done its best is approximately $(4.435872 \times 10^{20}) \times (1 \times 10^{-10})$. Let us say that 40,000,000,000 is near enough to the correct figure.

Some of the most noteworthy of the contributions of the General Electric Research Laboratory have been in the field of high vacuum research, and in this work the Langmuir high vacuum pump has played and is playing a very important part. Briefly, the device—the invention of Dr. Irving Langmuir—is a mercury vapor pump of condensation type. The simplest comparison between the action of the pump and things we

see every day is to say that the air is removed by the pump in a way similar to that in which air, dust, and papers rush after a fast-moving train. A stream of mercury vapor in the pump corresponds to the express train.

Theoretically the pump has no lower limit beyond which it ceases to function. How it operates is most easily explained by referring to the accompanying elementary diagram of an all metal pump (Fig. 1). The metal cylinder, *A*, has two openings, *B* and *C*. The vessel to be exhausted is connected at *C*, and *B* is connected to the backing pump, a vacuum pump which assists by creating a fairly high degree of vacuum at the outlet of the Langmuir pump. Within the cylinder, *A*, there is a funnel-shaped tube, *F*, resting on the bottom of *A* and open at the top. Over the upper end of the tube is suspended an inverted cup, *E*. Surrounding the outside of the cylinder, *A*, is a water-cooling jacket, *J*, extending from the level of the outlet *B* to above the level of the lower edge of the cup, *E*. Mercury placed in the cylinder, indicated as *D*, is heated electrically or by other means and thereby evaporated. The vapor goes up through the funnel, *F*, is deflected by the cup, *E*, and directed downward and outward against the water-cooled walls of the cylinder, *A*, where it is condensed. This condensed mercury falls to the bottom of the cylinder, *A*, and returns to the mercury at *D* through small openings beneath the funnel, *F*, ready to repeat the cycle. The gas from the vessel to be evacuated, entering the pump at *C*, is forced down along the walls of the cylinder, *A*, and out the tube *B* by the downward blast of mercury vapor. In actual design the pump is more complicated in construction, but the operating principle is unchanged.

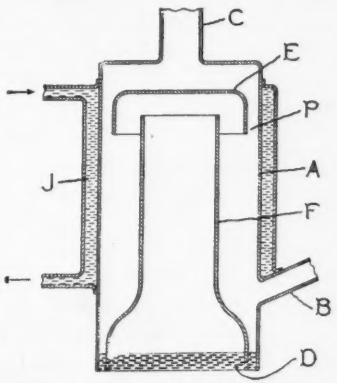


FIG. 1.—Elementary design of the metal form of the Langmuir mercury vapor pump of condensation type.

When it comes to evacuating a tube, there is more to the process than simply connecting the tube to the pump and starting operations. Metal and glass both liberate enormous quantities of gas when they are heated, so it is necessary to heat these and all other parts of the device to be evacuated. The glass must not, however, be heated to such an extent that it becomes soft enough to collapse under the difference in pressure.

In the larger diagram (Fig. 2), *O* represents an oven, and *G* the tube to be evacuated. The oven can be at either atmospheric or partial pres-

sure, depending upon the temperature at which the tube is to be maintained during evacuation. Between the tube, *G*, and the Langmuir condensation pump, *P*, there is placed a liquid-air trap, *T*, which prevents any mercury vapor from ascending into the tube, *G*, and which condenses

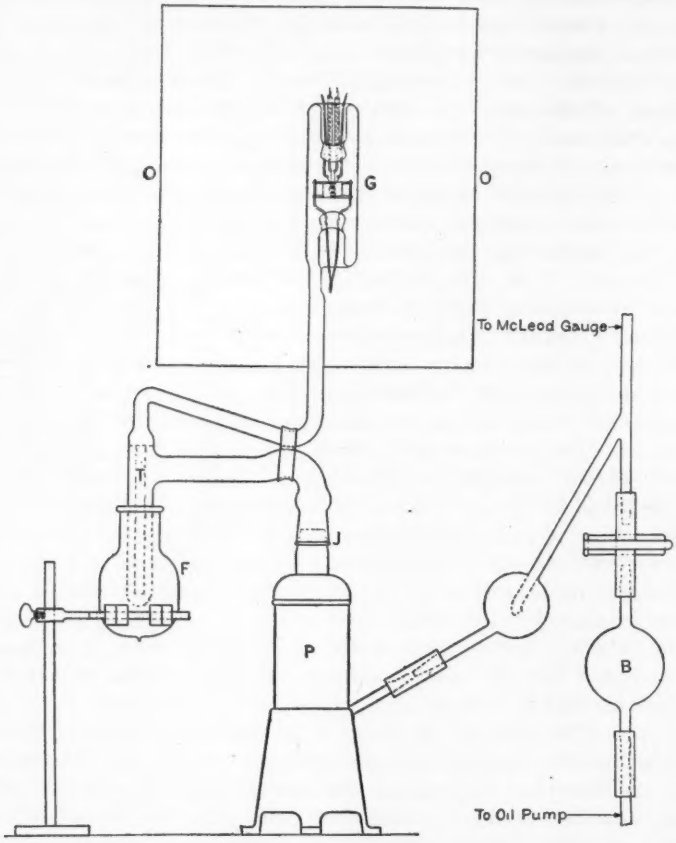


FIG. 2.—Arrangement of Langmuir pump and accessory apparatus for obtaining high vacua.

condensible vapors such as water, thereby assisting in the exhaust. The liquid air is held in the thermos bottle, *F*. The discharge or rough side of the Langmuir pump is connected to a McLeod or other sensitive vacuum gage for measuring the gas pressure, and to an oil pump which reduces the back pressure in the Langmuir pump. The oil pump discharges the gas molecules into the air, completing the work.

Such is the equipment with which General Electric scientists have been able to conduct their remarkable investigations in the realm of vacua.

Reference was just made to the fact that both the metal and glass parts of the tube to be evacuated should be heated so as to expel all gas and moisture. The metal should be heated to a higher extent than the glass, and an unusual type of furnace makes such a procedure possible.

There is apparently such a paradox as cold heat—at least there is the fact that in the Research Laboratory of the General Electric Company there are men who nonchalantly thrust their bare hands into an electric furnace which melts metals with ease. Still another astonishing fact about this furnace is that white mice will stay in it, even though the current is on and even though it is a simple matter for the mice to run out of it if they desire to do so. Again, it is possible to heat to incandescence the interior of a radio tube without heating the glass bulb itself, simply by inserting the tube in the furnace. Another interesting experiment can be performed with an incandescent lamp, to the base of which there has been attached a single loop of wire; by bringing the lamp near the furnace, the filament can be made to glow.

It will be noted, however, that before a person thrusts his hand into the furnace he is careful to remove any rings from his fingers. Similarly, the metal drinking cup for the mice is not placed in the furnace itself but in an extension of it, although the mice spend most of their time in the furnace proper.

The secret is that the furnace heats electrical conductors only, and the reason is that the equipment is a high frequency induction furnace.

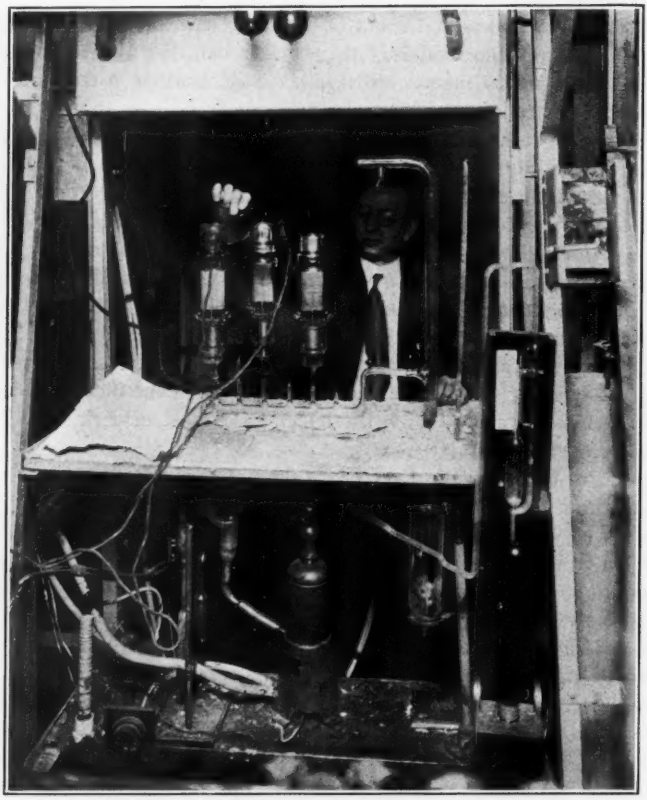
The furnace can be likened to a special transformer in which the primary is a coil of copper conductor, within which is placed the mass of conducting material which is to be heated or melted. This material serves as the transformer secondary. The current, fed into the coil at relatively high voltage, is reduced in voltage in the secondary, with a corresponding increase in amperage.

The current in the primary does not materially heat the coil, but the mass of metal serving as the secondary is rapidly heated to the melting point—and even higher if so desired—because of the rapid changes or oscillations in the current. These rapid changes also keep the melt in constant motion, so that thorough and complete mixing of alloys is assured. The operating voltage and amperage can be used to regulate the temperature, and the furnaces are so constructed that different frequencies can be employed—some work requires relatively low temperatures or low frequencies, and others require much higher temperatures or frequencies. Frequencies ranging from 90,000 to 1,000,000 cycles per second have been used, with from 300,000 to 500,000 cycles as average.

Ring-type induction furnaces, of which many of large size are in com-

mercial use, are designed on a different principle—that of an iron-core transformer in which a loop of molten metal serves as the secondary. The two types of furnaces differ in many respects. The frequency of the current is not the controlling feature in the ring-type furnace; and the ordinary commercial frequency is employed in the primary.

High frequency furnaces, have been in laboratory and commercial



LANGMUIR PUMP IN USE IN THE GENERAL ELECTRIC LABORATORIES

use for years. The melting of precious metals, the heat treatment of steel tools, and the mixing of special alloys are among the industrial applications of this type of furnace; and there are many other fields in which the apparatus can, and will, be employed.

One of the most interesting applications of the high-frequency furnace is in the manufacture of radio tubes. A tube might appear to be so com-

pletely exhausted that no trace of gas is apparent, and yet as soon as the filament is lighted there might be plenty of evidence that the tube contains gas—the presence of gas being indicated by a bluish haze within the tube. The metal and glass absorb large amounts of gas and water vapor, and added quantities stick to the surfaces. The bubbles, driven out by the heat from the tube filament, must be expelled from both the glass and metal parts of the tube. It is not possible to subject the glass to anywhere near as high a temperature as the metal parts require. The high frequency furnace solves the problem.

While the tube is being exhausted it is kept at as high a temperature as the glass will withstand without softening and collapsing, but this temperature is not sufficient to boil the gas and moisture from the metal parts. Just before the radio tube is sealed from the vacuum pump it is placed for a moment within a high-frequency coil. The metal parts immediately become red hot and the bubbles of gas and vapor are boiled out. The tube is then sealed from the pump, with the knowledge that later heating of the tube by the filament will not cause further release of bubbles.

In this age of machinery, it almost necessarily follows that the high frequency induction heating of the tubes is automatic. Just before the tube is sealed from the pump, a high-frequency coil on the end of a mechanical arm automatically descends over the tube, and for a few moments the tube is subjected to the field of the coil. The metal parts glow, the gas bubbles escape and are removed by the pump, the coil is automatically removed, and the tube is ready for the sealing process.

The high frequency furnace used in vacuum tube work would hardly be recognized as a furnace. It is simply a coil of copper conductor attached to a wooden handle, drawing its power from a nearby metal cage on wheels. Within the cage is the equipment for changing the ordinary 60-cycle power to oscillatory current of the desired frequency. It includes a step-up transformer, a couple of radiotrons, and a bank of high-voltage mica condensers.

High frequency and high vacuum—millions of cycles and millionths of an atmosphere—are two requisites of vacuum tube production which research has provided.

New Use Found for Wood Alcohol Waste. Lactic acid, a chemical which has numerous industrial uses, can be made from the waste in the manufacture of wood alcohol, members of the American Chemical Society were told by E. G. Sharrard, of the Forest Products Laboratory of Madison, Wis. The work was done in collaboration with W. H. Peterson, E. B. Fred, and E. A. Martin.

The wood sugar liquor remaining after the alcohol manufacture, which was formerly discarded, is treated with nitrogen and calcium carbonate to produce the lactic acid.—*Science Service*

FIFTY YEARS OF PHARMACEUTICAL HISTORY*

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Students of the history of chemistry encounter the names of many who were either specifically trained in pharmacy or were associated continuously with pharmacy throughout their whole careers. The facts regarding their pharmaceutical training and experience are usually overlooked or ignored by historians of chemistry and the part that pharmacy has played in the development of the science is usually under-estimated.

Among those who have attained prominence in the field of chemistry were a few who practiced pharmacy throughout their lives, their interest in chemistry being of secondary importance. Among those were Lemery, the two Geoffroy's, Baumé, and Scheele of the 18th century and Serturner, Pelletier, Caventou, Vauquelin, Thénard, Courtois, and Balard in the 19th century. Among those who were trained pharmaceutically but who later spent most of their time in the field of pure chemistry were Macquer, Margraff, Gmelin, Klaproth, Rose, Trommsdorf, and Buchner of the 18th century, and Proust, Davy, Dumas, Liebig, Poggendorf, Mohr, Pelouze, Wittstein, Fehling, Pettenkoffer, Fresenius, Vitali, Dragendorff, and Attfield in the 19th century. This list should be sufficient to convince the most skeptical person of the marked influence which pharmacy has had upon the development of chemistry.

In 1858 Liebig paid tribute to pharmacy in these words: "Only about 70 years ago was chemistry like a grain of seed from the ripe fruit separated from the pharmacists' science; with Black, Cavendish, and Priestley's days a new era began. Medicine and the useful arts had prepared the soil upon which this seed was to germinate and flourish."

Pharmacy has developed along very different lines from those which have characterized chemistry as is easily observed in contrasting the modern drug store with that of several generations ago, and yet the underlying basis of pharmacy (which is its service to the public in matters concerning the preparation of medicines and compounding of prescriptions) is not only essentially the same but has been improved by the educational progress which has occurred during this same period. One of the most outstanding factors in the development of pharmacy during the period which has elapsed since the centennial exhibition of 1876 is the "organization which has been so thoroughly effected in all branches of the pharmaceutic art." The American Pharmaceutical Association, now in its 75th year, is representative of the professional needs of pharmacy. The National

* Abstract of a paper read before the joint session of the Section of History of Chemistry and the Division of Chemical Education at the 72nd meeting of the American Chemical Society, Philadelphia, September 9, 1926.

Association of Retail Druggists, now more than one-quarter of a century old, takes care of commercial and legislative needs of the pharmacists, while the National Wholesale Druggists' Association, the American Drug Manufacturer's Association and the American Association of Pharmaceutical Manufacturers take care of their respective fields. There have also been strong associations developed within the states and powerful local associations in some cities. The value of organizations of this kind is shown when the need arises to oppose legislation inimical to the profession.

The American Chemical Society has upon at least one occasion benefited through the assistance rendered by pharmaceutical organizations in contesting legislation which would deprive chemists of some of their rights.

Another line of development and progress has been in the improvement of standards which are compiled and revised principally by pharmacists and under the supervision of pharmacists, *i. e.*, the United States Pharmacopoeia and the National Formulary. The present status of both of these books is very satisfactory, I believe, and a tribute was recently paid to the United States Pharmacopoeia by a writer in one of the journals of the American Chemical Society, who particularly praised that section of the book dealing with reagents and tests and stated specifically that excellent reagents for general analytical purposes could now be obtained by simply specifying "U. S. P." quality.

One of the factors which compelled greater attention to the revision of these two important books was the passage of the Food and Drugs Act in 1906 which made these two works the legal standards throughout the land for drugs and medicines entering into interstate commerce. They have also been adopted as legal standards in most of the individual states of the union.

The fifty-year period just past has seen the phenomenal development of coal-tar synthetics, of which there is still no end in sight, the rise and fall of elixirs, the popularity of pills and tablets in place of the nauseous liquid remedies of by-gone days. The newest development in drugs seems to be in favor of biologicals and serums, vaccines and gland products, and these are rapidly displacing many of the older remedial agents.

In the field of education there has been a continuous improvement, largely stimulated by an organization of the pharmacy colleges themselves, originally called the American Conference of Pharmaceutical Faculties and now functioning under the name of the American Association of Colleges of Pharmacy. The entrance requirement for pharmacy is now four years of high school, the same as for ordinary courses leading to the bachelor's degree in science, and the minimum course for a degree permitting the holder to apply for registration as a practicing pharmacist is now three years.

There are many colleges, however, which are giving four-year courses

in pharmacy leading to the baccalaureate degree, which are comparable with the baccalaureate courses in other sciences and the fact that these longer courses are well patronized is evidence of the progress being made.

During this fifty-year period there have come and gone many noted characters in the field of pharmacy. Some of these have left their impress upon the field of chemistry as well and they are representative of various parts of the country and various fields of pharmaceutical work. Among these may be mentioned the names of Caspari, Chandler, Diehl, Hallberg, Hynson, Lyons, Maisch, Oldberg, Prescott, Remington, Rice, Sadtler, Searby, Squibb, Stevens, and Whelpley.

College Failures Traced to Speech Defects. Glib and clear-cut speech is not a parlor accomplishment but an everyday necessity for college girls, judging by a speech census taken among students at Mt. Holyoke College.

The investigation has revealed that nearly half of the students who have entered the college in the past four years have been somewhat imperfect in speech Sixteen per cent were so obviously defective that it was necessary for them to take corrective work in speech training during the freshman year.

The list of students handicapped by poor speech included a large proportion of those who failed in their courses. One explanation offered for this is that there is a close connection between the ability to speak clearly and accurately and the ability to read rapidly. The student who reads slowly and inaccurately is unable to do the same amount of work as the more skilful reader.

The percentage of defective speech for the general population is believed to be considerably higher than among the college students. Teachers making the speech census told the students that good speech is an economic as well as a social asset. The college can assist the student to improve his or her personality in this respect; but the easiest time for the formation of correct speech habits is when a child is learning to talk, they were told.—*Science Service*

Paper from Cornstalks Declared a Possibility. Cornstalks, the largest single item of waste of America's largest industry, farming, have had their challenge answered not by an American scientist but by an Hungarian. Dr. Bela Dorner, head of the laboratories of the Royal Hungarian Railways, has recently come to this country with a process which he states is commercially practicable for the utilization of the stalks in the manufacture of paper, rayon, auto finishes, and many other products for which wood pulp at present is the only satisfactory basis. A number of New York capitalists have become interested in the possibilities of Dr. Dorner's method, and a prominent consulting chemist retained by them has reported favorably on it, after a series of large-scale tests.

It has long been known that cornstalk substance is chemically and physically suited for the needs now met only by wood pulp, but certain practical difficulties prevented the development of a stalk-pulp industry. One of the chief obstacles in processes hitherto tried has been the necessity for cutting out the hard cross-plates at the joints, which made too great an expense for commercial development. In the Dorner process, however, the whole stalk is ground up, and it is claimed that the hard parts make no trouble in the later manufacturing stages.—*Science Service*

HYDROGEN SULFIDE AS A LABORATORY AND INDUSTRIAL POISON*

W. P. YANT, SUPERVISING CHEMIST, HEALTH LABORATORY SECTION, PITTSBURGH EXPERIMENTAL STATION, AND R. R. SAYERS, CHIEF SURGEON, BUREAU OF MINES

The odor of hydrogen sulfide characterizes the thoughts most chemists have of their course in qualitative analysis. This odor was regarded as being a concomitant of the air of that particular laboratory. Though the textbook may have stated that hydrogen sulfide possessed poisonous properties it was seldom thought of in that light. This was in a large measure due to the fact that it was given no emphasis in the lecture room which of course signified it was not a potential question for quiz or examination, and hence was a matter to be forgotten in passing. But when the subject of hydrocyanic acid was introduced the poisonous properties were elaborated upon until the student would wonder how anyone lived to describe its odor. The very shape of the symbol HCN was mentally transfigured into the conventional skull and cross bones.

As a matter of fact, hydrogen sulfide and hydrogen cyanide may be classed in the same category of poisonous gases. From comparative data the dosage of hydrogen sulfide required to kill most animals in a very short time is even less than for hydrogen cyanide—namely, 0.10 to 0.20,[1,2] and 0.30[2] per cent in air, respectively. On the other hand, the amount causing ill-effects from long exposure to low concentrations appears to be less for hydrogen cyanide. However, in either case the difference is not significant from the standpoint of health and safety.

The fact that the poisonous properties of hydrogen sulfide have been greatly under-estimated and not sufficiently emphasized has been reflected in the apparent existing indifference to the dangers from this gas and the slowness of chemists and doctors in recognizing it as a source of frequent cases of gas poisoning. In view of this it appears that a better understanding of its toxic effects should be given to students of chemistry, not only from the standpoint of avoiding unhealthy atmospheres in university laboratories where its dangers can be easily mitigated and controlled, but to bring the matter to the attention of the students so that they can properly evaluate the dangers from this gas when they become engaged in industries.

* Published with approval of the Director, Bureau of Mines, Department of Commerce.

[1] Sayers, R. R., and others, "Investigations of Toxic Gases from Mexican and Other High Sulphur Petroleums and Products," Bureau of Mines *Bull.*, **231**, 1925, 108 pp.

[2] K. B. Lehman, "Tabelle der Kleinsten Mengen schädlicher Fabrikgase, welche noch giftig sind und der Mengen, welche allenfalls ertragen werden" in Rudolf Kobert's "Kompendium der praktischen Toxikologie zum Gebrauche für Aerzte," Studierende und Medizinalbeamte Stuttgart, **1912**, p. 45.

Occurrence of Hydrogen Sulfide

Hydrogen sulfide is not merely a laboratory reagent. It has wide occurrence in nature and in industrial processes, and from these sources it has been a source of considerable trouble as an industrial health hazard. At present the most prevalent site of trouble from its natural occurrence is in the production and handling of certain types of high-sulfur crude oil. The hydrogen sulfide occurs as a constituent of the natural gas above the oil, or is dissolved in the crude petroleum. This is especially true in many Texas fields,[3] and also in Mexico and South America. As much as 8 to 10 per cent has been found in the gas of one particular field where in several cases it caused almost instantaneous death to men after only one or two breaths.

In the petroleum industry the greatest trouble from hydrogen sulfide is irritation of the eyes and respiratory tract. These occur by the hundreds and are the cause of much inconvenience and delay. Entire crews are frequently incapacitated for several days and in one specific instance more than thirty men were rendered unconscious, and as many or more cases of irritation occurred before the well was closed in. The odor of sulfide is continuously present in these fields. The buildings or equipment which have been painted with white lead rapidly change in color to a brownish black. The silver money in use at the camps is black from a coat of silver sulfide. Many dead birds and animals are found in the vicinity of the tanks and wells.

In the handling, shipping, and refining of these high-sulfur oils there is the menace of hydrogen sulfide.[1] The oil coming from the well contains large quantities of hydrogen sulfide in solution part of which is given up during the process of pumping to flow tanks, thence to tankers, and finally to storage tanks at the refineries. This escape of dissolved gas renders the vapors above the oil in all these containers exceedingly toxic. Danger from the dissolved gas or from hydrogen sulfide generated during heating persists throughout many stages of the refining process and numerous deaths and hundreds of cases of severe irritation have been caused.

In addition to this major natural source of trouble, hydrogen sulfide has been encountered in dangerous amounts, and has resulted in cases of poisoning in gypsum and sulfur mines and in the sinking of caissons and digging tunnels. To a lesser degree it has also been found in gases coming from marshes, sewage and the decay of organic material, in coal mines, volcanic gases, and in the water from certain springs.

Health hazards from hydrogen sulfide are also prevalent in various industries. These occur not only in those where it is used as a chemical

[3] W. P. Yant and H. C. Fowler, "Hydrogen Sulphide Poisoning in the Texas Panhandle, Big Lake, Texas, and McCamey, Texas, Oil Fields," Bureau of Mines Reports of Investigations, Serial No. **2776**, Oct. 1926, 20 pp.

reagent but in others where it is liberated in the process. As specific examples may be cited the manufacturing of chemicals, the manufacture of gas, in coal mining from the products of combustion of black blasting powder, in metal mining from the blasting of certain types of sulfide ores with dynamite, and in the refining of petroleum to which reference has been made.

Types of Poisoning and Occurrence of Symptoms

The possibility of poisoning is present wherever hydrogen sulfide exists. A study of the accidents caused by hydrogen sulfide gas shows that the cases may be readily divided into two distinct types—namely, (1) acute, or asphyxiation; and (2) subacute, or irritation, resulting usually in conjunctivitis (inflammation of eyes), and inflammation of the respiratory tract, such as pharyngitis (inflammation of the throat), bronchitis (inflammation of the lungs), and pneumonia. These types may be described briefly as follows:

Acute.—A study of the cases of acute poisoning shows that it results in almost immediate unconsciousness, followed by death if rescue is not quickly effected and treatment given. In cases where rescue and treatment can be quickly accomplished the victim usually regains consciousness almost immediately. Headache and nausea may exist for several hours after but in most cases they are able to return to work feeling almost normal in the course of two to three hours, or at least in a day or two.

Typical cases of acute hydrogen-sulfide poisoning are as follows:

1. A student who had been generating hydrogen sulfide carelessly opened the hoods which contained the gas and breathed some of it for a period of possibly one minute. He fell unconscious to the floor, and his fellow students carried him to fresh air. No treatment was given and he was unconscious for only a few minutes. After regaining consciousness he went home, but returned to college the second day following. No after-effects were noted.

2. A gauger who opened the hatch of an oil tank for the purpose of measuring the quantity of oil was found dead on the ground below.

3. An oil-well driller and his helper unexpectedly drilled into the gas and were both found dead on the derrick floor.

4. A chemist engaged in the manufacture of cadmium sulfide opened the lid of the reaction tub. He fell unconscious from hydrogen sulfide poisoning before he could replace the cover but by falling into a zone of fresh air be recovered in a few minutes.

Subacute.—In subacute cases, symptoms of irritation of the eyes and respiratory tract are found. The degree of poisoning varies with the concentration of the gas present and the length of exposure. Typical subacute cases of hydrogen-sulfide poisoning are as follows:

1. A laborer worked all night in an atmosphere containing a small amount of hydrogen sulfide. He complained that his eyes pained. The following day his cornea was lusterless and exceedingly painful. Marked lacrimation (tears in eyes) and photo-

phobia (pain on exposure to light) existed. Following this the exposed portion of the cornea became cloudy, and later peeled. For several days the patient was unable to use his eyes, but at the end of a week the conjunctivitis cleared up and his eyes were not permanently damaged. He was able to return to work after ten days' treatment.

2. A drilling crew and connection crew were engaged in closing in an oil well from which natural gas containing a relatively small amount of hydrogen sulfide was escaping. Although the concentrations were not sufficient to cause acute cases of poisoning, nearly all the crew were affected by eye irritation with the result that the work was suspended for several days. The symptoms in these cases were, exceedingly great pain and a feeling of sand in the eyes, inflamed conjunctiva even to the extent of bulging, photophobia, and temporary blindness. A few felt a choking sensation and fullness of the lungs.

The occurrence and type of symptoms resulting from exposure to varying concentrations of hydrogen sulfide are shown in the table on the opposite page which has been compiled from various sources of data on men and supplemented in the higher percentages by data from investigations on animals.

Reference to loss of sense of smell will be noted in this table. This refers to the inability to detect the characteristic odor of hydrogen sulfide after a few minutes' exposure, and plainly shows that the sense of smell cannot be used as a reliable means for detecting dangerous concentrations. This phenomenon is noticed with practically all gases and vapors which have a strong characteristic odor. If the gas accumulated slowly it is very possible that dangerous concentrations would occur before one who was continuously exposed would detect it as a strong concentration. This explains the description given by many victims of poisoning, that they did not smell hydrogen sulfide but that unconsciousness was produced quickly and pleasantly.

Treatment

Conjunctivitis.—Consultation with physicians in oil-fields who have been treating these cases advise that the following treatment for conjunctivitis has given excellent results—not a single case failed to respond to treatment where the patient has done his part by following instructions:

1. Relieve pain by drops of butyn, or butyn and epinephryn, or holocain in severe cases in which the pain is not relieved by the former.
2. Follow with campho-borate. One doctor varies this practice by using boric acid ointment.
3. Drops of colloidal silver iodide (neo-silvol), or argyrol (5 to 10 per cent).
4. Throughout the treatment use hot compresses alternating with a cold compress if pain is too great.

Rhinitis, Laryngitis, and Bronchitis.—Irritations of the nose, throat,

TABLE I

TOXICITY OF H_2S ON MEN (COMPILED FROM THE WORK OF LEHMAN AND THE WRITERS OF BUREAU OF MINES BULLETIN 231)[1]

H_2S per cent	1/2 to 2 minutes	2 to 15 minutes	15 to 30 minutes	30 minutes to 1 hour	1 to 4 hours	4 to 8 hours	8 to 48 hours
0.010 .015		Coughing; irritation to eyes; loss of sense of smell	Disturbed respiration; pain in eyes; sleepiness	Throat irritations	Salivation and mucous discharge; sharp pain in eyes; coughing	Increased symptoms[a]	Hemorrhage and death[a]
.015 .020		Loss of sense of smell	Trachea and eye irritation	Eye and trachea irritation	Difficult breathing; indistinct vision; light shy	Serious irritating effects	Hemorrhage and death[a]
.025 .035		Irritation of eyes; loss of sense of smell	Irritation of eyes	Painful secretion of tears; weariness	Light shy; nasal catarrh; pain in eyes; difficult breathing; pain in head injection of conjunctiva	Hemorrhage and death[a]	
.035 .045		Irritation to eyes; loss of sense of smell	Difficult respiration; coughing; irritation of eyes	Increased irritation to eyes and nasal tract; dull pain in head; weariness; light shy	Dizziness; weakness; increased signs of irritation; and death[a]		
.050 .060	Coughing; collapse and unconsciousness[a]	Respiratory disturbances; irritation to eyes; difficulty of respiration; collapse[a]	Serious eye irritation; light shy; palpitation of heart; few cases of death[a]	Severe pain in eyes and head dizziness; trembling of extremities; great weakness and death[a]			
.060 .070	Collapse Unconsciousness[a]	Collapse Unconsciousness death[a]					
.070 .080	Collapse Unconsciousness[a]	Collapse Unconsciousness death[a]					
.080 .10	Collapse Unconsciousness[a]	Collapse Unconsciousness death[a]					
.10 .15	Collapse Unconsciousness[a]	Collapse Unconsciousness death[a]					

[a] Data secured by the authors from experiments on dogs, which, according to Lehman in *Arch. Hyg.*, **14**, 135–89 (1892), have a susceptibility similar to men.

and lungs are treated symptomatically. One doctor has had good success in the use of "anespray" for the throat.

Treatment for Subacute Poisoning

All of these treatments should be under the supervision of a competent physician. While the symptoms may appear trifling, they should receive medical attention at once because of the complications which often arise. The application of hot and cold compresses in themselves will relieve pain in cases of conjunctivitis, and irrigation with boric acid will be helpful in slight attacks, but only sterile compresses and eye cups should be used. The difficulty of self-diagnosis as to the severity of the attack, makes "home remedies" and "home treatment" inadvisable. If a man had a natural tendency toward eye or respiratory weakness, his exposure to hydrogen sulfide gas might result in a complicated condition which would prolong the recovery period. This makes it especially imperative that all cases should be treated by a competent physician.

It has been reported that solutions containing cocaine have been prescribed to be used as an eye wash in cases of "gas eyes," the name applied to conjunctivitis caused by H_2S. This is a very dangerous practice because the pain is relieved temporarily, and men will go into the hydrogen sulfide gas repeatedly when they should be receiving proper care. These repeated exposures to H_2S and use of such eye washes often result in corneal ulcers and in permanent injury to the patient's eyes.

Treatment of Acute Poisoning

In many cases of acute hydrogen sulfide poisoning there is an immediate cessation of respiration. Thus any treatment to be effective must be given immediately and be so simple that it can be given by fellow workmen. There is not time for summoning aid before beginning to resuscitate the victim. In view of this the following treatment is outlined:

1. Get the patient into fresh air.
2. Give artificial respiration by the Schaefer or prone method,[4] if breathing has ceased, become markedly labored, or impaired.
3. Summon a doctor.

If breathing has ceased or ceases during treatment, artificial respiration should be continued until breathing resumes, or at least for a period of three hours, unless the patient is pronounced dead by a doctor.

A Hint to Laboratory Workers

In concluding the reading, many teachers of chemistry will no doubt

[4] "Manual of First-Aid Instruction for Miners," by a Committee of Surgeons on Standardization of First-Aid. Revised by R. R. Sayers, Bureau of Mines, 1921, pp. 33–5.

wonder how they have escaped being poisoned by this laboratory commodity. A few may even be inclined to be skeptical. However, if they are reminiscent a considerable number will recall cases where students became unconscious from breathing hydrogen sulfide. In most cases of acute poisoning recovery was very rapid and the incidents were explained, or thought of more in the terms of fainting, choking, or couldn't get his or her breath. No direct thought is given to the direct poisonous action of the hydrogen sulfide, and to the fact that death might have resulted in a few minutes if the victim had breathed the gas a few seconds longer. Fortunately, in most chemical laboratories, hydrogen sulfide is generated in relatively small amounts and in most cases the atmospheres capable of producing acute poisoning exist only around the generator. When a student breathes concentrations high enough to make him unconscious he falls down or away from the poisonous atmosphere.

In addition to these acute cases it is believed that many more cases of irritation of the eyes and respiratory tract occur among the students. These may have passed unnoticed or if observed at all in the large majority of cases have been attributed to other causes.

Calcium in Blood Controlled by Nerves. The amount of calcium, the element essential for building bones and teeth, present in the blood is apparently regulated by the nervous system, Dr. Alfred F. Hess of New York, well-known expert on calcium-deficiency diseases, told the American Society of Biological Chemists, meeting recently in Rochester, N. Y.

The calcium in the blood is diminished by about a third if certain nerves in the abdomen are cut, he stated, and the supply remains low for many days. But if the spinal cord is cut just the opposite takes place, calcium increases in the blood system from 50 to 75 per cent. In other words the amount of this important constituent in the blood seems to depend quite directly upon the activity and integrity of the nervous system.—*Science Service*

Says Coal Was Formed in Ancient Lake Beds. Evidence that coal was formed at the bottoms of ancient lakes, and not in vast swamps or bogs as commonly supposed, is advanced by Prof. E. C. Jeffrey of Harvard University, in an article which will be published in a forthcoming issue of *Science*.

Prof. Jeffrey's studies were conducted on coals from geological formations of Tertiary age, which is much more recent than the source of most of the coal in this country, but which supplies remains of plants more like those growing today and hence more significant to the botanist so far as their habits are concerned. Earlier studies of similar coals had disclosed wood structures which were taken to be those of cypresses, and since cypresses are swamp trees this was taken as evidence for the classical theory of coal formation. Prof. Jeffrey's investigations, however, have shown that these supposed cypress-like woods were really from redwoods and similar trees that normally grow on well-drained upland soils and never in swamps. His conclusion, therefore, is that these coal beds are the remains of great masses of water-logged vegetation washed down from the hills by rivers and deposited in the bottoms of huge lakes.—*Science Service*

STANDARDS IN LABORATORY RESULTS VERSUS STUDENT INTEGRITY

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"Ninety-four out of ninety-six of your students are dishonest." Such was the verdict of a colleague when shown the data from an experiment in beginning chemistry. Putting it mildly the instructor had been startled by the evidence which gave rise to this remark. The class, with the exception of two, had reported results close to the accepted value for the percentage of oxygen in the atmosphere. The instructor had found it impossible to obtain such results by the method which the students claimed to have used.

The first reaction on the part of the instructor was to conceal these facts. It was felt that such overwhelming evidence from representative students of an honor system university must be a condemnation of the instructor of a most damaging character. However, he soon recovered sufficiently to convert the shock into the beginnings of an experiment in laboratory teaching. Time, sage counsel, and the new teaching technic developed from the experiment have altered the instructor's viewpoint. He is now prompted to report the observations and findings to those having similar problems.

The students who gave rise to the above verdict and the following data were enrolled in beginning chemistry. The course included three hours of lecture and three hours of laboratory per week throughout the school year. It was required of those specializing in home economics and physical education, and was recommended for those desiring chemistry as part of a liberal education.

There were sixty-two from home economics, twenty-six from physical education, and thirteen from liberal arts. Of these, ninety-two were women and nine were men, while forty-four had taken high-school chemistry and fifty-seven were without previous chemistry.

The determination of the percentage of oxygen in the atmosphere by the pyrogallate method was the assignment for the day. The directions were those of a 1922 edition of a well-known laboratory manual. It was understood that the students would be required to repeat the experiment if their results were not within reasonable limits set to include those of the majority of the class as satisfactory. It was generally expected that such experiments would yield results that did not deviate more than five per cent from the accepted value.

Ninety-six of the class reported. The results were tabulated and the acceptable limits set from 19 to 23%, the correct value being 20.9%. On this basis, only the two members of the class who reported less than 19% were required to repeat the experiment.

The instructor was much pleased with these results. It seemed that

here was a quantitative experiment which gave satisfactory results with beginners in laboratory science. Even the poorer manipulators obtained results which approximated the accepted value in a most gratifying fashion.

TABLE I

SHOWING DISTRIBUTION OF RESULTS FROM FIRST PERIOD

Number of students	Percentage of oxygen (Average of two best values)
9	20.9
94	19.0 to 23.0
2	Less than 19.0

With such a desirable type of quantitative experiment the acceptable limits for the next class might be made even more restricted.

One student, delayed by the inability to get satisfactory results, came to the instructor with the difficulty several days after the regular period for the assignment. In consequence the instructor found that he also was unable to obtain satisfactory results. The use of freshly prepared solutions and a most favorable interpretation of the directions did not alter the situation. With repeated trials, in some cases even simulating the methods of the careless student, the instructor never obtained more than 17% as the percentage of oxygen in the atmosphere. (It was only by using double the concentration of pyrogallate indicated in the directions that the correct value could be obtained with the method used. The students could only have used the less concentrated, inadequate solutions.) It was certainly a striking fact that ninety-four of the class had reported checks on values above 19%.

At the next meeting of the class this same assignment on the percentage of oxygen in the atmosphere was given out as though entirely new. No comments were made on the previous assignment of this same experiment. The procedure was modified in that students worked in pairs and repeated

TABLE II

SHOWING DISTRIBUTION OF RESULTS FROM SECOND PERIOD

Number of trials	Percentage of oxygen
42	19.0 to 21.9
105	6.8 to 19.0

Number of pairs of students	Percentage of oxygen (Two best results within limits indicated)
2	20.9
17	19.0 to 21.1
32	6.9 to 18.9

the experiment until they checked themselves within 5%. All results obtained were turned in at once and the reports written outside the laboratory were dispensed with.

These results could have been "doctored" as those in the first report

must have been, though it would have been less convenient to do so in the laboratory than at home. Some students may have refrained from altering the results because of the peculiar circumstances of a repeated assignment.

It is remarkable that, though the students were working in pairs on an experiment they had previously performed individually, only four acceptable values were reported as a result of the first trial. Contrast this with the fact that previously only two out of ninety-six had failed to report acceptable values. The conflicting results indicated in the tables could only be explained by assuming that a great many of the results reported had not arisen from actual experiment though it had been the intention of the students that they should be so regarded.

The instructor confronted the class with the two tables of data, the statement of his own inability to get higher than 17%, the explanation of how he came to do the experiment, and the fact that the class had signed their names to the reports from which the two conflicting sets of data had been taken. Further details of how the situation was met with this particular class, though interesting, are not a part of this writing.

Ninety-eight per cent of these students were not dishonest from their own point of view. Like the infant who recognizes no wrong, they could do no wrong in this respect. What a misfortune, even when considered in this extenuating light! If this sort of thing is to be the result of setting standards of accomplishment in quantitative work, should quantitative work or at least the idea of insisting on quantitative results be given up entirely? Certainly quantitative results by the methods used in the experiment quoted are not to be tolerated. Every teacher in beginning laboratory science meets this problem. How shall standards be maintained in quantitative work which will give educational value to the results of such work? Science is impossible without quantitative standards and such standards are most irksome and seemingly unreasonable to beginners. To expose students to quantitative methods and problems without demanding quantitative results is absurd. To require even reasonable standards of beginners accentuates the problem of honesty in laboratory work in a most astonishing fashion. It seems that much of beginning science is taught without concern for the quantitative demands. A few teachers raise the standards at the expense of scientific integrity, being unconscious of the fact. Apparently no one has solved the problem of maintaining satisfactory requirements and at the same time a high degree of integrity in the attitude of students toward the laboratory report. Many readers will say, "This situation does not hold in my course; this misguided individual required the impossible of his students and of course they rebelled." May any such test their own classes by similar methods.

The problem brought out so forcibly has received far more thoughtful

attention than it might otherwise have claimed. Gradually the difficulties are being overcome through the selection and presentation of laboratory material. Though the problem is far from a complete solution the results so far attained indicate the method in use as being one of much promise. Certainly the equilibrium has been shifted to a much more favorable state than that indicated by the experiment on the percentage of oxygen in the atmosphere. The underlying idea has been to make the apparent and immediate rewards in laboratory work as certain and as easily attainable by honest as by dishonest methods. It has been possible to make it increasingly difficult to substitute dishonesty for conscientious work.

Certain types of laboratory exercises are particularly adapted to what the educators called the problem method. The use of such laboratory problems together with the adoption of certain methods of laboratory quiz and of laboratory reports furnish the basis for the solution of the problem. Such methods have the reputation of being educationally sound but difficult to use with large classes. Their adaptation to university classes of one hundred to two hundred students is giving results which indicate that a satisfactory solution to the difficulty may have been found.

Laboratory assignments in which each student is given an individual problem of determining an unknown of quantitative character are very useful in stimulating conscientious laboratory work. Experiments including the percentage of water in a hydrate, the density of metals, and the equivalent weight of metals, come under this class. With the equivalent weight determination, and to a certain extent the density determinations, the total number of different unknowns available is small. The difficulty may be met by obtaining each metal in a variety of forms as sheet, stick, wire, pellet, etc. Where even as few as three metals are available such a variety of forms gives the spice of individual unknowns and defies any comparison which students are likely to make. In such experiments students may be permitted to make reports showing reasonable agreement between duplicate determinations and to profit by any suggestions the instructor may make on the quality and correctness of the report. Records should be kept on such preliminary reports. There should be a definite scaling down of the final grade in accordance with the number of unsatisfactory preliminary reports. This is to prevent the guessing for grades. With such a problem the student is compelled to carry out the experiment if he would make a satisfactory report. The variety in the appearance of the different samples is so great that the method of guessing the identity of the unknown, and back calculating for results, becomes unpopular.

The determination of such known constants of nature as the molecular weight of sulfur dioxide or the percentage of oxygen in the atmosphere

take on the desired characteristics if properly presented. The following quotation from the laboratory directions shows how this may be accomplished.

"This method of determining the molecular weight of sulfur dioxide is subject to certain errors inherent in the procedure and apparatus. These errors lead to a definite deviation from the accepted value when the student performs the experiment with care and accuracy. Accordingly, the 'best possible result' with this apparatus and method has been determined by the instructor and from the reports of previous classes. In evaluating the work the 'best possible result' rather than the generally accepted value will be used as a standard."

On this sort of an experiment students show enough variation so that comparison of results by students in the laboratory does not give the key to the correct deviation. This "best possible result" is often from 1 to 2% above or below the accepted value. A greater variation than this is not desirable for obvious reasons. Methods may be chosen or modified to control the "best possible result." Thus, this type of experiment, of which there are many examples, is made to take on the character of a real unknown. The dishonest student finds no easy short cut to a high grade and the incentive for straightforward work becomes greater.

The identification of a single unknown salt or of a commercial baking powder may be assigned as individual problems of qualitative character. Students enjoy such problems. It is apparent that here again the situation is such as to make the highest rewards most certain for the intelligent conscientious student.

Individual problems in chemical preparations where the student is judged on the quality and quantity of the product submitted, may also be adapted to the stimulation of honesty. It is open to the objection that students may purchase the product they are supposed to prepare. The selection for assignment of preparations not readily purchased largely obviates this difficulty. Thus, the method of getting a good preparation by laboratory work becomes the only one available, and hence the most used.

The intelligent use of the short written quiz may serve as a tremendous force for individual and conscientious work. At the beginning of each laboratory period a short written quiz on the assignment of the previous period, especially on the practical difficulties of the laboratory, stimulates the actual doing of experiments in contrast with the method of getting out a report with the least expenditure of time and energy.

Reports written outside the laboratory, where supervision is impossible, could be discarded entirely if it were not that they act as a spur to the lazy minded. Hence, report grades should be given the minimum weight consistent with this purpose. Students have appreciated this benefit of being required to write a formal report. One class voted by an over-

whelming majority to retain the formal report requirement in preference to doing away with it.

To review briefly, then, the use of individual problems of a quantitative and qualitative character, the selection and modification of methods for determining the constants of nature, the choice of preparation problems to avoid easily purchasable products, the use of the short written quiz, and the assignment of the minimum of grade credit to the formal report have all been made to serve in the solution of the problem of laboratory standards versus student integrity. Their use has reduced the student's temptation to improvise laboratory results. It has permitted a requirement of standards in laboratory work consistent with the educational value of the results of such work. The teaching of the true scientific attitude toward laboratory work has been materially aided by the adoption of these methods.

The fact that such methods are suitable to large classes is indicated by the fact that they have been used successfully with a class of one hundred and eighty students. It required about two-thirds of one instructor's time where fifteen hours of teaching per week is the normal maximum teaching load. In addition to this, about twenty-five hours per week of student help as readers and laboratory assistants were required.

The use of such methods and principles leaves this pressing problem of standards in laboratory work and the value of the results far from a complete solution. However, their application to several classes indicates that the methods have great promise. Perhaps the extent of the progress, obtained by the use of these methods, may be measured in the future by submitting a class to a situation similar to that of the erring ninety-four.

No doubt many are scornful of such an emphasis of grades or of the concern for those deluded individuals who think that an education can be obtained without paying the price in work. Others feel that the injustices coming from the neglect of these problems may greatly hinder the development of many weak and shortsighted students who might otherwise acquire a keen appreciation of real values. The observation that some individuals are apparently acquiring an education at a low cost of personal effort makes such methods irresistible to the weak and unthinking. It is inevitable that the activities of the dishonest type shall be repressed throughout society or else society must join them in making chaos. So it is with a small section of society, the class in beginning chemistry, justice in the immediate rewards (grades) is a most important factor in bringing about that great object of all teaching, the constructive development of the student.

The pursuit of science strengthens the intelligence, without weakening the energy, without blunting the sensitiveness, without chilling any of the good qualities the germ of which has been placed in the human heart by Nature.—FRANÇOIS ARAGO

AN ANALYSIS OF ANALYTICAL RESULTS

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An analysis of sodium chloride yielded the following results, inaccurate despite the fact that the constituents totaled 100.0 per cent.

Na	38.8%
Cl	61.2%
	100.0%

If we divide the percentage of each constituent by its equivalent weight we obtain the quotients 1.687 and 1.724, respectively. If we now divide the smaller of these numbers by the larger we obtain the value 97.85%. For this value the name "Dickinson Number" of the analysis is suggested and it is upon the calculation of this number that the analysis of analytical results depends.

The "Dickinson Number" is primarily intended for use in connection with the results of the analysis of a mixture of several salts. Let us consider a liter of a solution containing 1.000 g. each of sodium chloride, calcium chloride, calcium sulfate, and sodium sulfate. The tabulated results of the analysis of this solution are reported ionically in parts per million, although the method is equally applicable to any system of reporting results. Each result is divided by the corresponding equivalent weight. The numerical value for the sum of the quotients of the positive ions is equal to the numerical value for the sum of the quotients of the negative ions, showing that the amounts found of the positive ions are balanced by the amounts found of the negative ions. In other words, the "Dickinson Number" of this analysis is 100.0%.

CALCULATION OF THE "DICKINSON NUMBER" OF AN ANALYSIS

	Pts./(10)^6		Eq. wt.		Quotient	Sums
Na^+	717	÷	23	=	31.2	
Ca^{++}	654	÷	20	=	32.7	63.9
Cl^-	1247	÷	35.5	=	35.1	
SO_4^{--}	1382	÷	48	=	28.8	63.9

"Dickinson Number" = 63.9 ÷ 63.9 = 100.0%.

There are three voices of Nature. She joins hands with us and says Struggle, Endeavor. She comes close to us, we can hear her heart beating, she says Wonder, Enjoy, Revere. She whispers secrets to us, we cannot always catch her words, she says Search, Inquire. These, then, are the three voices of Nature, appealing to Hand, and Heart, and Head, to the Trinity of our Being.—PROF. J. ARTHUR THOMSON

THE CORRELATION OF THE GENERAL CHEMISTRY OF THE METALS WITH QUALITATIVE ANALYSIS

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Few teachers of first-year college chemistry would hold that the usual course in elementary qualitative analysis is expected to produce analysts. It is, however, well adapted to present, in a practical manner, certain fundamentals of chemistry. The average student who takes this course finds an interest in its systematic development, its practical application and its directness that holds his attention and creates a feeling that he is learning how to find out the very thing he had often wanted to know, *viz.*, what things are made of. On the other hand, his study of the general chemistry of the metals with occurrence, preparation, and properties repeated with each new metal and each new compound is often uninteresting and, to him, disconnected and therefore fruitful of little more than the storing of unrelated facts most of which are forgotten soon after the final examination is over. Assuming that the aim of these two courses is to give the student a general knowledge of the chemistry of the metals, to prepare him for the more careful manipulation of qualitative analysis and to develop in him a certain ability to draw conclusions from facts, *i. e.*, to enable him to use the scientific method of thinking, it is evident that the latter course, at least, often falls short of its purpose.

It was to correct this difficulty as well as to discourage the tendency on the part of many students to memorize facts without orienting them that prompted the writer, about four years ago, to attempt a correlation of these two subjects so as to give the general chemistry of the metals the benefit of the interest obviously created by the qualitative analysis. The result has been especially satisfactory and has demonstrated that the two subjects can be presented in complete harmony as a single course with an increased interest on the part of the student. He obtains a more systematic and logical idea of the metallic elements and is less inclined to memorize apparently unrelated facts without classifying them. Two fundamental generalizations form the basis of classification, *viz.*, the periodic table and the law of mass action. By means of these the student is able to understand the reasons, not only for his manipulations in qualitative analysis, but for the occurrence, preparation, and properties of the different metals and their compounds. Their use, therefore, is explained at the very beginning of the course and the student soon learns to use them in a qualitative way.

During the first semester's work on the chemistry of the non-metals the student has become somewhat familiar with the more common acid radicals and has found that double decomposition reactions are not only reversible but that the equilibrium produced may be shifted by the ad-

dition or removal of one of the substances concerned. He has also been given an idea of the periodic table and has seen its value in a few cases. He is, therefore, in a position to proceed at once with the qualitative analysis of the acid ions while he is learning the use of the mass law as a means of explaining necessary procedures, and of the periodic table as a means of classifying the elements. Although many prefer to leave the acid analysis for the end of their course and direct the students' attention mainly toward the metals, much value can be obtained by a systematic study of the acid ions, their stability and relation to each other. It not only serves as a practical illustration of the relative stability and therefore usefulness of the different salts but brings to the student a clear realization of the meaning and effect of oxidation and reduction, two important chemical processes. It also serves as an excellent introduction to metal analysis since the reactions involved are comparatively simple.

A laboratory study of the acid ions is well suited to the more general study of the alkali metals in lecture and recitation since the study of these metals is largely a study of their salts, many of which are of commercial importance because of the acid radical. The course, therefore, is best begun with a review of the periodic table and of its value in correlating the facts of chemistry, followed by an explanation of the mass law and its use in chemical manufacture. The student is thus prepared for a logical consideration of metals as differentiated from non-metals and for the study of the alkali metals and their compounds. During this time he has completed the acid analysis in the laboratory.

The metal analysis is then begun with a study of Group V, instead of Group I, as is often done when qualitative analysis is given as a separate course. It has been found, however, that this offers no handicap since it gives the student an opportunity to become acquainted with the methods of analysis before encountering the difficult theory and technic necessary for satisfactory work in Groups II and III. In order to correlate the general chemistry of the metals with this order of analysis, the study of the alkali metals is followed by that of magnesium and the alkali earths and then by Division A metals,[1] continuing through manganese. The study of Group III analysis will have begun in the laboratory when aluminum is reached. Iron, cobalt, and nickel, therefore, should follow manganese. So far the lecture and laboratory work may be made to parallel as closely as is possible with students of varying abilities in laboratory skill. It will be noted that this arrangement enables the lecture and recitation work to be presented in the most logical order when considered from the standpoint of the periodic table, the structure of the atom and the chemical conduct of the elements themselves. The most active and most basic metals as well as the most stable compounds are found in the

[1] See Periodic table by the author, THIS JOURNAL, **1**, 173 (Oct., 1924).

study of the alkali metals. These properties become gradually less prominent as one proceeds with Division A metals through the different groups. Variable valence and the acidic character of elements also approach gradually. The student is, therefore, in a position to see the reason for the differences found in the occurrence, preparation, properties, and uses of the elements and compounds encountered.

In order to continue this sequence, the study of copper, silver, and gold should follow that of iron, cobalt, and nickel and these should be followed by the other Division B metals in their regular order through the periodic table. With but one or two exceptions these metals belong to Groups II and I of the systematic analysis and hence can easily be made to parallel their laboratory study. A close relation is, therefore, obtained throughout the course between the systematic analysis and the apparently less orderly occurrence, preparation, properties, and uses. The interest developed by the former extends over the latter probably because the student is able to see the relation between the two and can hope to retain more of what he learns.

Such a correlation possesses the value of introducing the more difficult concepts in a gradual manner. In acid analysis the student gets a practical working knowledge of double decomposition reactions with which he has already become acquainted. He encounters, however, instability in compounds as a property to be reckoned with. This shows him in a practical way that the methods used in the manufacture and use of substances, as well as in their analysis, must be governed by the character of the compounds concerned. He finds amphoterism in aluminum and sees how it is used and why it exists and, therefore, looks for it in chromium. He encounters variable valence and, therefore, oxidation-reduction in the study of chromium and manganese and at the same time sees how it is used to advantage in the separation and detection of these elements. He comes to the study of iron, cobalt, and nickel, the transition group, by very gradual changes in the properties of the elements. He can, therefore, see the relation existing between the elements and can get a basis for correlating his facts and for drawing reasonable conclusions. The transition character of Group VIII prepares him for the great difference he will find between the alkali metals and copper, silver, and gold and so tends to keep his faith in the periodic table as a means of correlating the facts of chemistry. The complex ion as a practical problem and as a useful agent is met in connection with Division B metals and so appears late in the course. All of these concepts appear naturally as laboratory problems. The student can readily see the need for their explanation since they have a direct bearing on practical analysis as well as on the chemical manufacturing industry. Instead, therefore, of becoming additional tasks for him to perform they appear as useful tools in his analysis and as explanations for the facts he has obtained.

A LITTLE TALK ABOUT ENERGY*

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If you tie a string of small firecrackers to a puppy's tail and then ignite the firecrackers so that they go off one after another, you know what will happen. That puppy will go suddenly away from there. Each pop will give the pup more pep. No credit for originality in this idea is due me for it is recorded in the book of Judges that Samson once carried out a similar experiment by tying firebrands to the tails of three hundred foxes and turning them loose in the dry cornfields of the Philistines with results which you can easily imagine. Both of these experiments, however, will serve to illustrate the effect of energy upon matter.

In the past we have been accustomed to think of matter as inert, and of energy as something distinct from matter but which can act upon matter and produce changes in it; we cling to that idea today and for ordinary purposes it seems all right. But our scientific friends tell us that we must modify our ideas; that our notions about matter and energy are out-of-date. They tell us that we must no longer think of matter as dead, inert; we must no longer think of its structure of molecules and of atoms as we have been thinking of them. It is doubtful if even Dalton would recognize the atom in its present supposed form. To parody Scott:

> The father of the old idea
> Returning to this mundane sphere
> To view the atom's new career
> Would never know his child.

We have thought of matter as made up of molecules and of molecules as made up of atoms, but now we must think of atoms as something like miniature solar systems having central positive nuclei around which there revolve numbers of negatively charged electrons, and the electrons in turn, if a recently announced discovery is verified, have smaller bodies revolving about them. This condition of affairs reminds one of those lines in Hudibras in which fleas are described as having

> Other smaller fleas to bite 'em
> And so on down, ad infinitum.

Our research friends tell us that matter is vibrant with energy; nay, they tell us that matter is a specialized form of energy, that the two are interconvertible and that no hard and fast line can be drawn between them.

> And so from out this science clatter
> We learn that energy is matter;
> But matter soon turns out to be
> A special form of energy.

* Delivered (with illustrative experiments) at Manchester, N. H., Oct. 22, 1926, before the Science Section of the New Hampshire State Teachers' Association.

Some day, perhaps, the tremendous energies locked in the atoms will do the world's work.

We have always known that energy was important but, in the light of these recent revelations, it seems more necessary than ever that the topic, energy, should be given prominence in our teaching. What have we been doing about it in our science instruction? Our brothers in the physics department have spent considerable time developing the idea of energy under such topics as kinetic and potential energy, latent energy, etc., and like Johnny Walker they are "still going strong" in that way; but we of the chemistry fraternity, I fear, have not done our full duty by the subject.

In extenuation of our failure in this respect, we may plead that we have not received the encouragement of our authors. Just take down from the shelf of your chemical library the various secondary-school chemistry texts and look up the references to energy as noted in the index and observe how little is given. In the average text you may find from a few lines to a quarter page in one place and no reference to the subject elsewhere in the book. I think now of but one book which devotes a full chapter to this important subject. Of course, all texts refer to heat, light, and electricity in connection with chemical reactions but the reference is purely incidental and the idea of energy is not stressed; the word energy does not appear. It seems to me this might be done better. I readily agree that for the beginner in chemistry the principal thing is to become familiar with the chemical properties of the substances used or produced in chemical reactions, and to understand something of the molecular changes which take place, but I plead for some attention to that important factor which underlies the chemical action or is produced by it.

Now what can we do to bring the idea of energy clearly and forcibly to the attention of our pupils? Since our texts do not stress the idea, I know of no better way than the method of class demonstration by the teacher accompanied by carefully prepared, thought-provoking questions. It is a principle of psychology that strong sense appeals make vivid impressions and leave lasting concepts. Of course, such impressions may sometimes fail as in the case of the rustic who saw the hippopotamus at the circus and went away saying; "There ain't no such animile!" But we can at least make the attempt to bring the idea of energy to the front by experiments calculated to make strong sense appeals, following up such experiments by questioning designed to focus thought upon the matter in hand. The experiments which are to be shown here have been chosen to bring out the idea of energy and the ones selected may, I hope, be less well known than those commonly described in the school books. You are all familiar with the use of heat in preparing oxygen, of electricity in decomposing water, etc., and will be more interested in something different. The forms of energy most common in chemical work are: light,

heat, and electricity. Let us consider some experiments in the above order.

Probably the illustration most commonly given for the chemical action of light energy is the taking of pictures. "The witchery of Kodakery" is all right but the trouble with the illustration is that, while the final result is visible enough, we cannot see the immediate effect of the light as it falls upon the film. An experiment which shows a visible effect is to be preferred. Here is such an experiment. I mix equal volumes of 4 per cent solutions of mercuric chloride and ammonium oxalate, divide the liquid into equal parts, place tube number one in the dark, and ask a student to expose tube number two to the brightest sunlight he can find. When the tubes are again compared we see that there has been a marked change in tube number two and none in tube number one. Now is the time for the teacher to question on what has happened and why, stressing the idea of light energy. In this connection it will be interesting to find out whether electric light can be substituted for sunlight; also what will happen to tube number one if it is kept in the dark for several days. For those who may wish to try this experiment the equation for the reaction is:

$$2HgCl_2 + (NH_4)_2C_2O_4 \longrightarrow 2HgCl \downarrow + 2CO_2 + 2NH_4Cl$$

Results similar to this may also be obtained by mixing ferric chloride solution with potassium ferricyanide solution, adding a little oxalic acid and exposing a portion of the mixed liquids to the action of sunlight. This is, of course, the familiar reaction of the blue print.

Another example of the effect of light is shown in the use of the selenium cell. Here is a block of selenium, sister element to sulfur and like it a non-conductor of electricity. But if selenium be exposed to strong light its conductivity is greatly increased, a curious and interesting fact which has been utilized by Arthur B. Reeve in one of his Craig Kennedy stories. This cell has a thin film of selenium into which are fused two copper wires; the cell is connected to a relay and a dry cell. Connected with the relay is a small motor and other cells to furnish current. As you see, the motor is not running. Strong light thrown upon the selenium causes a current to flow through the relay which closes the main circuit and the motor begins to rotate. Sunshine might thus start our factory wheels to turning in the morning. There is a device using selenium cells by which black beans are automatically sorted from white ones, due to the difference in the light reflected from each bean as it passes in the sorting apparatus.

It would be interesting if we could learn just what molecular or other changes the light energy produces in the selenium but I do not know that definite information on that point is yet available.

When exposed to strong light certain substances have the power to absorb light energy which is given off again slowly when the light energy is shut off. Here, for example, is a small tube containing zinc sulfide. As you can see it does not glow when placed in this light-proof box. But I expose the tube for a few moments to the strong light of the electric lamp or to direct sunlight and then place the tube in the box. You can now see, as the box is passed around, that the substance is glowing with a greenish light. What causes this peculiar fluorescence? The teacher should strive here as elsewhere to drive in the idea of the absorption of energy. One does not need to go into a discussion of the Lyman and other effects which are the results of movements of electrons from one orbit to another but the simple idea can be developed that light energy has been absorbed and then given up again.

A curious case of light absorption is shown with the dye fluorescein. I heat together in this tube a little phthalic anhydride with a little resorcin to which a drop of concentrated sulfuric acid is added. After heating and cooling, the dye is extracted with sodium hydroxide solution and the whole poured into this tall jar of alkaline water. You see the interesting and varied effects as the different wave lengths of light are absorbed and others are reflected.

The tremendous work done in the world by light energy may here be mentioned. The inspired writer of Genesis is quite right in recording that light was created before plants and animals made their appearance upon the earth. "Hail Holy Light! Offspring of Heaven first born and of the eternal coeternal beam," sings Milton in Paradise Lost. The need of light energy to develop and to sustain life is thus indicated. The conversion of water and carbon dioxide into the starches, sugars, and cellulose by photosynthesis is worthy of class discussion and the use of light energy in the treatment and cure of disease is a matter of record. Truly we are "children of the sun." As you doubtless know, certain chemists, notably Baly of Liverpool, have actually succeeded in producing sugary substances from carbon dioxide and water by the action of ultra-violet light, thus imitating one of the great processes of Mother Nature. Thus one by one the secrets of the universe are revealed. No threat of Caucasian crags deters man from bringing down the Promethean fire from heaven. But we must hasten on to other matters.

Here are some small crystals of copper sulfate which I now heat in this dry tube. Water is expelled and the crystals crumble to a grayish powder. As the water goes out energy goes in. Here is some more of the same material in this corked tube. Probably if we were to put water on this powder it would turn blue again. Would you like to try the experiment? Let me put a little of this gray powder on the palm of your hand. Now, with this medicine dropper, I will let one drop of water fall

upon the cold powder so that you can see what happens. You see it is turning blue. Oh, it gets hot, does it? Well, why does it? Here again the teacher has a fine chance to discuss energy. How was the water driven out of the blue crystals? Is heat a form of energy? As the water went *out* what went *in* to the powder? What was stored up in the powder? What ought to happen when the water is put back? And similar questions.

Several other substances act similarly. Dehydrated barium chloride gives up about 7000 calories of heat when its water of hydration is restored while copper sulfate yields some 18,500 calories per gram-molecule. Plaster of Paris and copperas powder act similarly.

Here is some fresh quicklime in this pan. I pour cold water upon it as long as it is absorbed. The basic oxide is here uniting directly with the water to produce slaked lime. Here is a small frying pan which I place upon the lime. The heat produced by the hydration of the lime will presently suffice to fry an egg. Heat to the amount of 160,540 calories is liberated in the reaction. I do not recommend this method for frying eggs to the busy housewife but from an energy standpoint it is an interesting experiment. Questions naturally follow. How is lime made? How did the latent energy get into this lime? What should naturally follow when water is added? If the carbon dioxide originally driven out of the limestone were restored, would the lime get hot? Why? Suggest some other ways in which the energy liberated in the hydration of lime might be utilized? You can think of other questions to ask your class. Work out the idea of energy in all of this questioning.

In the preceding experiments we have seen that heat energy is liberated. May not heat energy be absorbed? Assuredly so. In this small beaker are 30 cc. of very cold water. I stand the beaker upon this small board which is wet with water. On stirring into the water 24 grams of powdered ammonium nitrate, sufficient heat is absorbed from the water in the act of solution so that the beaker is frozen to the board. Why does not the water in the beaker freeze too? Let your students think out the answer to that and to other questions.

Perhaps a still more striking example of the cooling effect of heat absorption is found in an experiment with methyl chloride. A little of the chloride is placed in a tumbler or beaker and then water is added. The rapid evaporation of the methyl chloride freezes the water and we have instantaneous ice. The various artificial refrigeration systems now being installed in apartment houses are based upon this principle. Sulfur dioxide, ammonia, and methyl chloride are the chief materials used for the refrigerant.

It is well known that some elements are much more active than others. Sodium is more active than copper for example. The chart of the displacement series shows the relative activities. Much more energy is

used up in the liberation of the more active elements like potassium from their compounds than is used in the preparation of copper or mercury. A more active element will, therefore, displace a less active one, a principle exemplified in the philosophy of the famous Scotch bandit Rob Roy who, according to Wordsworth, believed that

> "They should take who have the power
> And they should keep who can."

Now here is a thermit, a mixture of aluminum grains and ferric oxide. Aluminum is much more active than iron as you see by the chart. I fill this sand crucible nearly full of the thermit, first placing an iron nail in the crucible to act as a sort of metallic thermometer; then a kindling mixture of aluminum powder and barium peroxide is stirred in on top of the thermit, a strip of magnesium ribbon stuck in to act as a fuse, the ribbon is ignited and you see what happens. Enormous energy is developed, and a temperature of some 2000°C. is produced in a very few seconds. The heat of formation of aluminum oxide is 392,600 calories while the heat of decomposition of the ferric oxide is only 197,600 calories per gram molecule so that there is a surplus of about 195,000 calories of heat energy which may be utilized in any way we wish. As you look into the crucible you get some idea of what the heat of the reaction is like. On cooling the crucible with water and cracking it open we find a mass of slag which when broken off discloses a ball of iron. But what has become of our iron nail? Under the fierce heat of the chemical action it has disappeared, being melted and fused with the iron formed by the reaction between the aluminum and the iron oxide. Energy!

Enormous energy is developed in the combustion of some of our gaseous fuels. Here is an oxyhydrogen blowpipe in which I am using ordinary illuminating gas and oxygen. As you see, sufficient heat energy is developed to burn up this iron nail in a shower of sparks. When acetylene is used 315,700 calories per gram-molecule are liberated. In all of this experimental work the idea of energy should be stressed and thorough questioning done to make clear the importance of energy in the reactions studied. But we must hasten on.

The ancient Greeks made Zeus the wielder of the thunderbolt, the brandisher of the lightning. But our modern wonder-workers have persuaded Zeus to turn his electrical energies into more useful channels and so we have the electric furnace with its many useful products, the electro-refining and plating of metals and endless other uses of the electric current. I can show here only a few experiments of the many which are possible on the demonstration desk.

This U-tube contains a water solution of sodium chlorate and sodium chromate with lead electrodes inserted. As the current flows you can

see the formation of "chrome yellow" or lead chromate, a pigment for paint. In the same apparatus we may use a solution of potassium iodide, alcohol and water with platinum electrodes and obtain iodoform. Both experiments illustrate the application of electrical energy to industrial purposes. What part does energy play in this experiment? What are the chemical equations involved? The tremendous energy of explosives should be mentioned. Some of these, such as guncotton and picric acid, may easily be prepared by the teacher. You can easily make TNT if you want to; there is no danger in the process.

A few experiments with explosives may be of interest. I load this glass cannon with gunpowder, insert the charge (a cork), slip the tube inside a protective brass tube so that only the lower end of the glass tube shows. Now I take careful aim at the gentleman with the red necktie and heat the end of the tube. Presently the cork goes out as you see and the finder may have it.

Dangerous as some of the high explosives are when detonated in an enclosed space, they are quite different in character when simply burned. Here is a round grain of smokeless powder, used as a high explosive in the United States Army. Just hold this grain between the nails of your thumb and first finger. Now I will touch a match to the powder. You see it burns. Blow out the flame. Let me light it once more. Blow it out. Sometimes you can light the powder three times before it burns down sufficiently to make another attempt impossible.

Now let me lay this strip of guncotton across your palm. I bring a lighted match to the high explosive cotton. Did you feel the heat produced as the guncotton burned? There are many more experiments with explosives but we cannot do them now.

"Energy cannot be created nor destroyed but it can be transformed." So your pupils will chant when you ask them for the law of energy. But did you ever show the actual transformation of energy? Consider this apparatus. Current from the dry cell (a source of chemical energy) flows out as electrical energy. Around the wire there is a field of magnetic energy. When switch number one is put down the motor turns and we have mechanical energy. Switch number two throws on the lamps and we have the energy of heat and light. I insert the electrodes into the small U-tube and we have decomposition of the solution or chemical action. So we have all these forms of energy successively derived from the chemical energy of the materials in the dry cell.

Energy! We should stress it more in our teaching! Energy turns our factory wheels, it does our work, operates our radios, speeds our boats and trains, blasts the way for our Panama canals and mountain tunnels, cooks our breakfasts, and enables you to sit like "Patience on a monument" and listen to this dry talk. That must take energy!

Samson once slew a thousand men with the jaw-bone of an ass. Lest those present be likewise slain with Samson's weapon I will retire right now to innocuous desuetude.

Lactic Acid Assures Long Life for Mayonnaise. Women scientists are attacking the practical problems involved in the preservation of food. Thanks to Dr. Miriam S. Iszard, of the department of bacteriology at the University of Pennsylvania, mayonnaise dressing, notorious among housewives for its inability to "keep," can now be preserved as long as five months.

Experiments in the bacteriology laboratory indicated that a spore-forming bacillus was responsible for spoilage in mayonnaise, says Dr. Iszard. Since bacteria cannot survive in an acid medium it was decided to try the effect of the addition of small amounts of lactic acid to the dressing. This acid is harmless from the point of view of health and it was found that a small proportion would check the growth of the bacteria causing decomposition. It was used in preference to vinegar, according to Dr. Iszard, because it does not affect the taste of the dressing as would the amount of vinegar necessary to inhibit bacterial growth.—*Science Service*

Experimental College Planned for University of Wisconsin. An experimental college, with 250 volunteer students, is to be conducted at the University of Wisconsin in order to find improved methods of teaching freshmen and sophomores.

During the first year the experiment will be limited to 125 freshmen, and in the second year freshmen and sophomores will both be studied.

Announcing the plan, Dr. Glenn Frank, president of the university, states that the experiment will enable the university to "test out forms of curriculum and methods of teaching so radically different from the prevailing curricula and methods that no university would feel justified in adopting them for its entire student body in advance of satisfactory tests under controlled experimental conditions."

President Frank states that the quality of the teaching staff of the experimental college will be such that, whatever methods be tried out, the students will not lose by not taking the regular courses. The students will receive the same credit for their two years of experimental education, as if they had enrolled in the main branches of the university.—*Science Service*

Geologic Summer School to Train-Tour Canada. A geological summer school on wheels, housed in a specially constructed sleeping, dining, and lecture Pullman car, will roll this year from the Atlantic to the Pacific over Canada's great mineral empire. The trip extending from July 15th to August 25th will be under the auspices of Princeton University and under the direction of Prof. Richard M. Field.

As foreign guests, two eminent foreign geologists, Prof. Leon W. Collet, of the University of Geneva, and Dr. E. B. Bailey, of the Scottish Geological Survey, will accompany the party of 23, which will include professors and practicing geologists as well as undergraduates and graduate students.

By living and traveling in the special car, a new mine or geological site can be visited nearly every day. The Canadian Geological Survey will coöperate in the instruction. Last year a similar trip was made across the United States and the combination of lectures while enroute and field experiences was proved to be an efficient method of instruction.

Rocks laid down in past ages, from a hundred million to a million years ago, will be seen at various points along the route. The deposits where the bones of gigantic dinosaurs are found, oil wells, copper and nickel mines and large industrial developments will be visited.—*Science Service*

A RAPID DETERMINATION OF OXYGEN IN THE AIR*

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The pyrogallol method for the determination of oxygen in the air is included as a standard method in advanced textbooks, but is not commonly given in the laboratory manuals accompanying high-school chemistry texts. A modification of this method may be made to suit the abilities of pupils in the high-school laboratory that will provide an easily solved, interesting, quantitative experiment in connection with the study of air.

The apparatus consists of a 15 cm. test tube, fitted with a two-hole rubber stopper, connected to a funnel by means of a rubber tube which can be closed by a screw clamp. In one of the holes of the stopper is placed a short piece of glass tubing, to which the rubber tube is connected, and the other is to be closed with a glass rod. Both the glass tubing and the rod extend just through the stopper.

The determination is made by bringing into contact with a definite volume of air a liquid which not only absorbs oxygen but in so doing flows into the tube which contains the air and fills a space equal to that previously occupied by the oxygen. The volume of this liquid can be easily measured and in this way the volume of the absorbed oxygen may be ascertained.

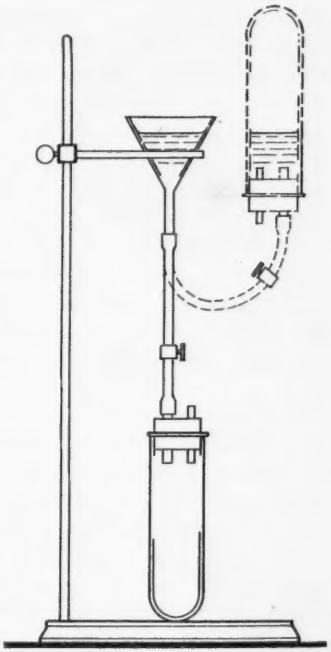
The solution used to absorb the oxygen is an alkaline solution of pyrogallol or pyrogallic acid, made by dissolving 5 g. of potassium hydroxide in 5 cc. of water, and 4 g. of pyrogallic acid in 10 cc. of water, and mixing the two solutions. This solution soon loses its strength when exposed to the air; hence the experiment must be performed rapidly.

The stopper is first removed from the test tube and the screw clamp closed. The liquid is then poured into the funnel and the screw clamp loosened to allow the liquid to fill the rubber tube and the glass tube completely. The clamp is then closed again and the stopper securely fitted into the test tube. The remaining hole of the stopper is now closed with the glass rod. This procedure allows the air in the test tube to remain at atmospheric pressure. A band of gummed paper is then put on the test tube to mark the level of the stopper. We are now ready for the action to begin, so the clamp is loosened and the liquid flows into the test tube as the oxygen is absorbed.

When the liquid has ceased to flow into the test tube, it is inverted and adjusted so that the levels of the liquid are the same in the funnel and in the test tube. This puts the remaining gas under atmospheric pressure again. Another band of gummed paper is put on the test tube to mark the upper level of the liquid. The clamp is now closed and the test tube removed from the apparatus and washed out.

* Paper read at a meeting of the Illinois Association of Chemistry Teachers, November 19, 1926.

The capacity of the test tube to the first band from the bottom is measured by pouring water into it from a graduate. This is the volume of the remaining gas, principally nitrogen, which was left in the test tube. The tube is now filled to the second band and the new volume noted. This gives the total air capacity of the tube. The difference of these two volumes is the volume of oxygen in the given amount of air. This number divided by the total volume of air taken gives the percentage of oxygen in the air.



Pyrogallic acid is a trihydric phenol with the formula $C_6H_3(OH)_3$ and is used in photography as a developer. It is a powerful reducing agent and precipitates gold, silver, and mercury from solutions of their salts, being itself oxidized to oxalic and acetic acids. Many dihydric phenols such as resorcinol and quinol show a corresponding behavior, but the monohydric compounds are much less readily oxidized.

The fact that this determination can be made in a few minutes makes it attractive to the average student because it eliminates the necessity of correcting the volumes of the gases according to Charles' and Boyle's laws. These calculations are necessary in the usual phosphorus experiment which must stand for twenty-four hours. Perhaps it is well to postpone them until later in the year's work.

New Chemical Element Obtained in Pure Form. Rhenium, the chemical element whose discovery was recently announced by Doctors Walter and Ida Noddack, has now been obtained in pure form. The first discovery was based on the finding of the characteristic lines in the X-ray spectrum as detected by photographic plates, but now the Noddacks have succeeded in obtaining, after long and difficult refining processes, a small quantity of the substance itself. They describe it as a black powder of high melting-point, that unites readily with a number of other elements. In an atmosphere of pure oxygen it ignites, forming a white oxide. The quantity so far obtained is very minute, only two milligrams, or seven one-hundred-thousandths of an ounce, and the experimenters are now at work to elaborate more of it which will permit of exact quantitative chemical examination.—*Science Service*

CORRELATION OF HIGH-SCHOOL AND COLLEGE CHEMISTRY

Introduction

At the Washington Meeting (1924) the Committee of Chemical Education of the American Chemical Society revised the "Standard Minimum High-School Course in Chemistry" in order to bring it as nearly as possible into accordance with the thirty thousand criticisms which had been made available through the various state Committeemen[1] and journal publications.[2,3] A preliminary syllabus for "A Minimum First-Year College Course in Chemistry" was also published in connection with this High-School Syllabus, for one of the main objectives which underlay the work of the Committee was to arrive at some correlation between high-school and college chemistry. In fact they considered this of far greater importance then the assembling of a list of topics—a task which has been ably performed by other committees.

The Committee has aimed to reduce any overlapping of the high-school and college syllabi to a minimum. Where overlapping seemed inevitable the committee tried to work out the syllabi in sufficient detail so that each instructor would easily see his responsibility.

Since the appearance of this 1924 report many requests have been received from the high schools and from various organizations of science teachers for a reduction in the quantity of subject matter required in the high schools in order that teachers might emphasize fundamentals more thoroughly and still have time to localize their courses. In compliance with these requests the Committee has undertaken the preparation of a second revision. This has resulted in the transference of a considerable portion of the high-school material to the college curriculum.

Undoubtedly it will appear to many high-school teachers that some of their favorite topics have been eliminated from the required part of the syllabus. They will readily observe, however, that the supplementary list serves to meet this situation. Furthermore if this supplementary list does not include material which the teacher considers desirable, he is free to substitute any of his own choices for any part or all of the supplementary topics, for these topics will be taught in college. He may prefer to put his extra time on the topics suggested in the supplementary reading list. Probably many of the teachers will use a great deal of the supplementary reading along with the required part.

State and College Board Syllabi

In preparing the high-school part both State and College Entrance Examination Board syllabi have been kept in mind. A careful survey

[1] THIS JOURNAL, **1**, 33 (1924).
[2] *Sch. Sci. Math.*, **23**, 777 (1923).
[3] *Ind. Eng. Chem.*, **15**, 1189 (1923).

will show that the report covers the essentials in both. As it now stands the teacher, through supplementary work, can make any part of the course as rich as he or she may desire.

Two Courses in High Schools

The Committee does not feel that it is practical or necessary to have two different courses in high schools, that is, one course for those who expect to attend college and one for those who do not. In the first place a boy or girl does not definitely know when he begins the study of chemistry whether or not he will attend college, and, secondly, certain fundamentals of chemistry must be taught before one can teach any type of a course in chemistry. These fundamentals are included in the required part, and are supposed to take only a portion of the allotted time. The use of the remainder of the time is optional, so that the teacher is free to teach food chemistry, agricultural chemistry, industrial chemistry or any other applications which he may desire or which his particular locality may require.

In a word the following objectives have governed the committee in its work:

1. To list only the minimum essential topics which are common to all localities, so that the high-school teachers will have time in developing the course to supplement these minimum topics with material which he considers especially suitable for his locality or for the future work of his students. (See list of topics for supplementary work as given on page 648.)
2. To prepare an outline which would cover the essentials of any state requirement and also the requirements of the College Entrance Examination Board.
3. To prepare an outline for high-school chemistry which is satisfactory for students who wish to get a general knowledge of chemistry as well as for those who are going to college.

The committee anticipates that the following objectives will govern the high-school teacher in developing the syllabus:

1. To show the service of chemistry to the home, to health, to medicine, to agriculture, to industry, etc.; in a word, to show the service of chemistry to the country.
2. To develop this service in chemistry around certain minimum fundamental topics, and, in doing so, to see that these minimum requirements are so well taught that they may be built upon as a foundation in college.
3. To train the student in keen observation and exact reasoning, and in the scientific attitude of mind.

4. To develop a careful correlation between recitation and experiment.

5. To encourage students to keep notebooks which shall be an accurate record of laboratory experience expressed in concise, clear English.

6. To encourage the placement of chemistry in the third or fourth year of high school after the students have had a year of general science, and a year of biological science or physics, or preferably both.

7. To build upon the earlier science courses and knit them together in the best possible manner.

8. To encourage students to use reference books in addition to their textbooks.

9. To help pupils to find themselves—*i. e.*, to discover whether they have an aptitude for further study in chemistry or applied science, and, if so, to encourage such students to continue their study of science in university or technical school.

10. The teacher is urged throughout the course to stress the general principles involved in the specific cases studied.

Topics for a Standard Minimum High-School Course in Chemistry

The teachers are advised to use their own order in developing the topics listed below. The order given here is only suggestive.

1—Water

(*a*) General distribution
(*b*) Physical properties: color, odor, taste, density, boiling point, freezing point
(*c*) Solution: solvent, solute, saturated solution, process of solution, degrees of solubility, factors affecting the solubility of a substance, suspensions
(*d*) Impurities in water: what constitutes an impurity; purification by boiling, distillation or filtration
(*e*) Crystallization: water vapor, water of hydration, deliquescence and efflorescence
(*f*) Chemical properties: composition of water, quantitatively by electrolysis and qualitatively by synthesis from copper oxide; contrasts of physical and chemical change; contrast of elements and compounds; stability of water; interaction of water with active metals; order of activity; interaction with oxides

2—Oxygen

(*a*) Preparation
Electrolysis of water
Industrial
Potassium chlorate (use of catalytic agent)
(*b*) Properties
Physical: color, odor, solubility in water, weight relative to air, weight of 22.4 liters
Chemical: formation of oxides in air and in oxygen, explanation of oxidation and combustion, kindling temperature
(*c*) Uses: necessary to life

3—Hydrogen

(*a*) Preparation
Electrolysis of water
Industrial
Action of certain metals—*e. g.*, sodium—on water
Replacement in acids by metals
(*b*) Properties
Physical: as with oxygen
Chemical: burns in air, reduction by hydrogen

(*c*) Uses (practical): oxyhydrogen flame, balloons, hydrogenation of oils
(*d*) Hydrogen peroxide, properties and uses

4—Laws, Hypotheses, and Theories

(*a*) Law of Conservation of Mass
(*b*) Law of Definite Composition (proportion)
(*c*) Atomic Theory including electron (simple treatment)
(*d*) Law of Boyle and Law of Charles, treated briefly with special reference to gases, not experimentally, but rather their application to the interpretation of change of volume
(*e*) Law of Gay-Lussac and Avogadro's hypothesis

5—Symbols, Weight, Volume Relations, and Chemical Changes

(*a*) Atomic weights (not their derivation), use in performing simply chemical calculations
(*b*) Molecular weights as explained by Law of Gay-Lussac and Avogadro's hypothesis
(*c*) Symbols and formulas, their meaning and use in writing equations
(*d*) Valence, including electronic interpretation (briefly)
(*e*) Equations and their use in expressing chemical changes, including gravimetric and volumetric equations
(*f*) Problems involving: (1) percentage composition, (2) weights of substances and volumes of gases concerned in chemical relations, and (3) the laws of gases
(*g*) Kinds of chemical changes: (1) oxidation and reduction as illustrated by direct combination, decomposition, simple replacement (substitution), including electronic interpretation; (2) double replacement (metathesis)
(*h*) Energy change treated qualitatively: heat, light, electrical energy
(*i*) Formulas and writing of equations for reactions already studied

6—Air

(*a*) Percentage of oxygen and nitrogen by volume
(*b*) Tests for water vapor and for carbon dioxide
(*c*) Liquid air: principle of preparation and source of oxygen and nitrogen
(*d*) Two proofs that air is a mixture and not a compound

7—Nitrogen

(*a*) Occurrence
(*b*) Properties
Physical
Chemical: non-supporter of combustion, general inactivity, negative tests
(*c*) Nitrogen fixation, as illustrated by plants, synthesis of ammonia, and oxides of nitrogen
(*d*) Uses (practical)

8—Nitric Acid

(*a*) Preparation
Industrial (from the air)
Sodium nitrate with sulfuric acid
(*b*) Properties
Chemical: action of dilute and concentrated nitric acid on copper and silver, test for nitric acid or a nitrate, decomposition products of different nitrates
(*c*) Uses: oxidizing agent, nitrocellulose industries, high explosives (briefly)

9—Ammonia

(*a*) Preparation
Decay of nitrogenous matter
Industrial (Haber process)
Destructive distillation of soft coal
Action of ammonium salt with non-volatile base
(*b*) Properties
Physical
Chemical: basic character of water solution, ammonium radical, formation of ammonium salts, test
(*c*) Uses: refrigerating agent, preparation of ammonia water

10—Acids, Bases, and Salts

(*a*) General properties: taste, action on litmus, etc.
(*b*) Solutions, conductors of electric current
(*c*) Activity of acids and bases

11—Theory of Ionization (Briefly)

(*a*) How theory explains electrolysis
(*b*) How theory explains neutralization
(*c*) Acid and base defined in terms of ions; test for hydrogen ions and hydroxyl ions
(*d*) Atom and ion distinguished

12—Sulfur

(*a*) Occurrence
(*b*) Extraction: American method (Frasch method)
(*c*) Allotropic forms: crystalline and amorphous
(*d*) Properties
Chemical: direct combination with metals, for instance iron and copper
(*e*) Comparison with oxygen
(*f*) Uses: vulcanizing rubber, making matches, making sulfur dioxide

13—Oxides of sulfur

(*a*) Sulfur dioxide
Preparation: burning sulfur, roasting of sulfide ores, action of an acid upon a sulfite
Properties
Physical
Chemical: action with water (sulfur dioxide test)
Uses: bleaching agent, reducing agent, refrigerant

14—Sulfuric Acid

(*a*) Preparation
Contact process
(*b*) Properties
Physical: specific gravity and boiling point
Chemical: affinity for water, dilute acid on metal and concentrated acid on copper, test for sulfate ion
(*c*) Uses: preparation of other acids, with reason for the same; manufacture of fertilizers; refining of petroleum, picking of metals

15—Hydrogen Sulfide

(*a*) Preparation: ferrous sulfide and dilute hydrochloric or sulfuric acid
(*b*) Properties
Physical
Chemical: combustion, action on metals, action on solutions of metallic salts

16—Halogens

A. Chlorine
(*a*) Preparation: one industrial method (electrolysis of water solution of sodium chloride); one laboratory method (oxidation of hydrochloric acid using manganese dioxide)
(*b*) Properties
Physical
Chemical: direct combination with other elements to form chlorides, tests, comparison with oxygen
(*c*) Uses: bleaching and disinfecting action
(*d*) Compounds: hydrogen chloride (the gas), and hydrochloric acid (the solution)
Preparation: from a chloride and sulfuric acid
Properties
Physical
Chemical: a typical acid as shown by taste, action on litmus and reaction with metals and bases; test for chloride ion
Use as a laboratory reagent

17—Carbon

(*a*) Occurrence
General distribution
Allotropic forms: diamond, graphite, amorphous forms
(*b*) Commercial preparation of useful forms: graphite, charcoal, lamp-black, coke, bone black
(*c*) Properties
Physical
Chemical: affinity for oxygen, action with calcium and silicon (electric furnace)

(*d*) Uses: common fuels containing carbon or carbon compounds, operation of household stoves and furnaces, reduction by carbon, decolorizer, adsorbent

18—Carbon Dioxide

(*a*) Occurrence: relation to plant and animal life
(*b*) Preparation: burning carbon or a carbon compound, action of acid on a carbonate
(*c*) Properties
Physical
Chemical: non-supporter of combustion, action with soluble hydroxide; brief treatment of its solubility in water, temporarily hard water, rôle of carbon dioxide in nature, plant growth, test for carbonate ion
(*d*) Uses: refrigerating, beverages, fire extinguishers, leavening agent in bread-making

19—Carbon Monoxide (Teacher's Demonstration)

(*a*) Preparation: from oxalic acid, reduction of carbon dioxide by carbon
(*b*) Properties
Physical
Chemical: combustibility, reducing power
(*c*) Uses: reducing agent industrially; constituent of water gas, coal gas, and producer gas
(*d*) Illuminating and fuel gases: manufacture and uses
(*e*) Poisoning by carbon monoxide

20—Metals in General

(*a*) Definition of metal, non-metal, mineral, ore
(*b*) Occurrence: free, combined
(*c*) General methods of extraction, roasting of non-oxide ores, reduction of oxide by carbon, electrolysis of chloride, hydroxide, or oxide
(*d*) Action of air, water (including steam) and dilute acids on the common metals
(*e*) General methods of preparing metallic salts: neutralization, acid plus metal, acid plus salt of a more volatile acid, acid plus metal oxide, or acid plus carbonate

21—Sodium

(*a*) Properties
Physical: metallic luster, hardness, color, power to conduct heat and electricity
Chemical: flame test; action with water, with chlorine
(*b*) Compounds of sodium
Hydroxide: commercial preparation (electrolytic process); properties as typical base; uses (cleaning agent, soap-making)
Chloride: occurrence in sea water and earth's crust; purification; uses
Carbonate: preparation by Solvay process; properties; uses (particularly industrial)
Acid carbonate: preparation; properties; uses; active principles of baking powders
Nitrate: occurrence; properties; uses
Flame test

22—Calcium Compounds

(*a*) Carbonate:
Occurrence: marble, limestone, shells
Properties: solubility in water containing carbonic acid (temporarily hard water), decomposition by heat, action with acids
Industrial uses: building materials, making of quicklime, flux in iron furnaces, glass
(*b*) Oxide: preparation (industrial); properties; industrial uses
(*c*) Hydroxide: preparation; properties; uses (mortar, its hardening)
(*d*) Sulfate: occurrence; properties; test; uses; permanently hard water contrasted with temporarily hard water
(*e*) Calcium phosphates: occurrence; preparation of fertilizer
(*f*) Fertilizer: presence of potassium, nitrogen, and phosphorus as ingredients

23—Iron

(*a*) Metallurgy (extraction from oxide ores, pig iron, blast furnace)
(*b*) Cast iron: physical properties
(*c*) Uses of cast iron: castings, etc.
(*d*) Steel: manufacture (Bessemer, open hearth, and electrical processes); carbon and manganese steels with reference to their industrial uses
(*e*) Protective coatings to prevent corrosion of iron and steel: tin (tinware), zinc (galvanized iron), nickel plate, enameled ware, paint

(*f*) Compounds of iron: ferrous and ferric compounds; oxidation and reduction of iron compounds; change of valence

24—Sources of Organic Compounds

(*a*) Destructive distillation of wood: methanol, acetic acid, charcoal
(*b*) Destructive distillation of coal: gas, ammonia, benzene, tar, coke
(*c*) Distillation and cracking of petroleum: gasoline, kerosene, vaseline. paraffin

25—Organic Compounds (Briefly)

(*a*) Sugar
(*b*) Starch
(*c*) Acetic acid
(*d*) Ethanol (ethyl alcohol)

Suggested List of Experiments to Accompany the A. C. S. Standard Minimum High-School Course in Chemistry

The following experiments are merely suggestive. Since the teacher (according to the third objective of the Committee) is free "to use his own order in developing the topics listed," it follows that he is also free to change the order of the experiments to correspond and to modify them to meet his own working conditions. Some teachers may find it difficult to cover all the experiments in this list. It is felt that the average high-school student should be able to do individually *at least* thirty-six experiments in a year and that of these at least four experiments should be of a quantitative nature. Since courses vary in different high schools, it seemed wise to draw up a list of more than thirty-six experiments and let the teacher select those most suitable for his school. Those experiments which the committee considers the most important and essential to a well-balanced course are marked with an asterisk. Experiments not well suited for individual work are marked as Lecture Experiments.

Introductory Work

* 1. To learn to handle apparatus properly: using the Bunsen burner; cutting, bending and annealing glass; weighing; decanting; filtering; etc.
* 2. To distinguish between a mixture and a compound.

Water Topic

3. To purify water by distillation.
* 4. To study solutions, solvent power of water, saturation.
5. To study solutions of electrolytes and non-electrolytes.
* 6. To determine the percentage of water of hydration in a hydrated salt; *e. g.*, copper sulfate, barium chloride, selenite.
7. To study the electrolysis of water or of an aqueous solution of an electrolyte. (Lecture Experiment.)

Oxygen Topic

8. To prepare oxygen from potassium chlorate, to study its properties, and to recover the potassium chloride and manganese dioxide.
* 9. To determine the change in weight on heating a metal in air.
10. To determine the weight of 22.4 liters of oxygen at standard conditions.
* 11. To study the structure of flame; the oxidizing and reducing flame.

Hydrogen

* 12. To study the action of metals (iron and zinc) on dilute hydrochloric and sulfuric acids properties of hydrogen.
* 13. To reduce copper oxide by hydrogen (or illuminating gas).
* 14. To determine the weight of magnesium (or aluminum) that displaces one gram of hydrogen

Symbols, Weight, Volume Relations, and Chemical Changes

* 15. To determine the weight of copper (or nickel) that will combine with one gram atomic weight of sulfur.

* 16. To study the relation of energy to chemical changes as illustrated by the evolution or absorption of heat, light, and electricity in chemical reactions. (Lecture Experiment.)

17. To study a few simple cases of reversible reactions.

Air

* 18. To determine the respective percentages of oxygen and of nitrogen in air. (Lecture Experiment.)

Nitric Acid

19. To prepare nitric acid. (Lecture Experiment.)

* 20. To study the properties of nitric acid, including its action with copper.

Ammonia

* 21. To study the preparation of ammonia from an ammonium salt and the properties of the gas.

Acids, Bases, and Salts

* 22. To study the preparation of typical basic and acidic oxides, their action on water, and their interaction.

Sulfur

* 23. To study the allotropic forms of sulfur.

Oxides of Sulfur

* 24. To prepare sulfur dioxide: (1) by burning sulfur; (2) from a sulfite and an acid; and to study the properties of the gas evolved.

Sulfuric Acid

* 25. To study the properties of sulfuric acid.

* 26. To prepare sulfuric acid from sulfur dioxide by the use of an oxidizing agent.

Hydrogen Sulfide

27. To prepare hydrogen sulfide and to study its properties.

Halogens

* 28. To prepare chlorine and to study its properties.

* 29. To prepare hydrogen chloride (hydrochloric acid) and to study its properties.

Carbon

* 30. To study the adsorptive and reducing powers of carbon.

Carbon Dioxide

* 31. To prepare carbon dioxide and to study its properties.

Carbon Monoxide

32. To prepare carbon monoxide and to study its properties. (Lecture Experiment.)

Metals in General

* 33. To study the displacement (electrochemical series) of certain common metals.

* 34. To study the preparation of soluble salts and the isolation of the product.

* 35. To study the preparation of insoluble salts by precipitation.

Sodium

36. To study the action of sodium on water, with recognition of the products formed.

37. To study quantitatively by titration the neutralization of tenth normal solutions of sodium hydroxide and hydrochloric acid. (Lecture Experiment.)

38. To study the action of baking powders and to determine their ingredients.

Calcium

39. To study the preparation and properties of calcium oxide, hydroxide, and carbonate.

* 40. To study hard waters and one method of softening each type.

Iron

41. To study the change from ferrous chloride to ferric chloride, and vice versa; oxidation reduction; to test for the ferrous and for the ferric ion.

Sources of Organic Compounds

42. To study the destructive distillation of wood and of soft coal.

Organic Compounds

43. To test for starch; to test for sugar; the hydrolysis of starch.

Extra Experiments

44. To test for sodium, barium, strontium, and copper by flame coloration.
45. To test for nitrate, sulfide, sulfate, chloride, and carbonate ions.
46. To study the color of ions.

II. List of Topics for Supplementary Study

Not to be required for college entrance but to be added if time permits.

Alloys, other than those containing copper
Aluminum and its compounds
Arsenic insecticides
Bleaching powder
Bromine and iodine, treated similarly to chlorine
Catalysis
Colloids, common examples and their application
Copper and its compounds
Electromotive series
Electronic structure of matter
Gold
Hydrogen equivalent (reacting weights not atomic weights)
Hydrogen sulfide with special reference to testing for certain metals
Iron compounds: oxides, hydroxides, sulfates, and chlorides
Lead: properties, uses, and compounds
Magnesium: properties, uses, and compounds
Mercury: properties and uses of the metal and of the chlorides
Periodic Table: elements arranged in order of atomic weights and atomic numbers
Phosphorus: preparation, properties, and uses
Radium and radio-activity
Rare gases of the air
Silver: properties and uses; relation to photography
Zinc: metallurgy, properties, uses, and salts

III. List of Topics for Supplementary Reading

Not to be required for college entrance but to be introduced to add interest to the topics in the required minimum outline and to be selected according to local importance and at the discretion of the teacher. Only suggestions for the teacher.

Adhesives. Gums, paste, dextrin, glue, casein, water glass (sodium silicate).

Artificial Stone. Lime, plaster, mortar, hydraulic cement, concrete, stucco, plaster of Paris.

Beverages. Charged water, soda, mineral infusion, tea, coffee, fruit juices (artificial flavors), fermentation.

Clay Products. Brick, pottery, stoneware, chinaware, porcelain.

Cleaning Agents. Acids: oxalic, hydrochloric. Alkalies: sodium hydroxide, soap (emulsification). Special solvents: carbon tetrachloride, benzene. Composition of trade-marked cleaning agents.

Coal. Composition and fuel values of different varieties. Distillation of coal tar, light oil, middle oil, heavy oil, tar, pitch. Relation to dyes and explosives.

Dyeing. Direct and mordant dyes.

Explosives. Black powder, nitroglycerol, dynamite, guncotton, trinitrotoluene.

Fertilizers. Soil fertility, elements needed by growing plant and function of each. Photosynthesis and carbon dioxide cycle. Nitrogen cycle and function of nitrogen fertilizers. Use of limestone and phosphate rock.

Foods. Classification; carbohydrates, fats, proteins, mineral matter. Starch preparation from corn; cooking to dextrin and to paste; hydrolysis to glucose. Sugars: preparation and refining of beet and cane varieties; conversion to caramel; inversion. Fats: olive oil, cottonseed oil, butter, oleomargarine, hardening oils by hydrogenation. Proteins: albumins, casein, gluten, peptones, gelatin, vitamins.

Glass. Manufacture of crown, flint, lead and special glasses; coloring of glass.
Ink. Iron ink, organic dye ink, carbon ink.
Leavening Agents. Baking powders (composition and reaction); yeast, soda.
Matches. Ordinary and safety types.
Metals. Used for basic purposes—iron, copper, aluminum, lead; for ornament—gold, silver, nickel; for alloys—bronze, brass, solder, type metal, antifriction or bearing metals; fusible metal; alloy steels; tests for metallic iron.
Nitrogen Fixation. Manufacture by the arc, Haber and cyanamid processes. Relation to fertilizers, explosives, and dyes.
Paint, Varnish, Etc. Oil paints and driers, varnish, shellac, copal, linseed oil, oil cloth, linoleum. Pigments: white lead, red lead, iron oxide, lead chromate, zinc white, lithopone.
Paper. Manufacture treated briefly.
Petroleum. Fractional distillation into burning oils, solvent oils, lubricants, paraffins. Problem of gasoline supply and possible exhaustion of petroleum.
Photography. Blueprints, plates, films, prints, toning, etc.
Poisons and Common Antidotes. Common inorganic drugs.
Preserving. Sterilizing, pasteurizing, desiccating, pickling by salt and sugar; common chemical preservatives and tests for them.
Refuse Disposal. Sewage, garbage; fermentation and putrefaction; civic problems; disinfectants and deodorizing agents.
Silicates. Treated briefly.
Textile Fibers. Natural and artificial silk. Wool: scouring, bleaching, felting, etc. Cotton: bleaching, mercerizing, etc.
Wood. Distillation of wood to produce methanol, acetone, acetic acid, charcoal.

Since one of the main objectives in this work is to bring about a closer correlation between high-school and college chemistry, the committee has worked out "A Standard Minimum First-Year College Course" as given below.

It will be noted that practically all of the required part of the high-school course with the exception of certain fundamental laws has been omitted from the college syllabus since it is expected that these topics will have been taught sufficiently thoroughly to answer for the student's first introduction to chemistry.

Standard Minimum First-Year College Course in Chemistry

It is expected that the instructor will use his own order in developing the topics listed below. The order given here is only suggestive.

Structure of Matter

1—Fundamental Laws (Experimentally Derived)

(*a*) Law of conservation of mass
(*b*) Law of definite proportion (composition)
(*c*) Law of multiple proportion
(*d*) Law of equivalent weights (hydrogen equivalent)

2—Atoms, Molecules, and Electrons

(*a*) Dalton's hypothesis
(*b*) Definition of atom and molecule
(*c*) How Dalton's hypothesis explains laws of definite and multiple proportion
(*d*) The structure of the atom (electrons)

3—Properties of Gases (Experimentally)

(*a*) Contrast general properties of solids, liquids, and gases
(*b*) Relation of temperature to volume under constant pressure (Charles' Law)
(*c*) Relation of pressure to volume under constant temperature (Boyle's Law)
(*d*) Problems involving a simultaneous application of the two laws, including correction for water vapor and difference in level

(*e*) Law of Gas Volumes (Gay-Lussac's Law)
(*f*) Avogadro's hypothesis

4—Molecular and Atomic Weights (Experimentally)

(*a*) Determination of the weight of one liter of oxygen
(*b*) Determination of molecular weight of hydrogen, taking oxygen as a standard
(*c*) Determination of molecular weight of substances which cannot be vaporized without decomposition
(*d*) Determination of atomic weights

5—Symbols, Formulas, Calculations (Review)

(*a*) Full meaning of symbol and formula
(*b*) Calculation of formula
(*c*) Percentage composition calculated from the formula
(*d*) Naming of chemical compounds

6—Valence (Review)

(*a*) Electronic conception of valence
(*b*) Given the formula to find the valence
(*c*) Given the valence to write the formula

7—Chemical Equations and Calculations (Review)

(*a*) Steps in writing an equation
(*b*) Review different types of equations
(*c*) Review oxygen, hydrogen, and water by writing equations involving them, classifying such equations according to (*b*)
(*d*) Equations as a basis of chemical calculations:
Where weight alone is involved
Where volume alone is involved
Where both weight and volume are involved

The Classification of the Elements

1—Atomic Weights and Atomic numbers

(*a*) Protons and electrons and their relative weights
(*b*) Helium and heavier atoms
(*c*) Isotopes
(*d*) Structure of the crystal
(*e*) Atomic numbers and their importance
(*f*) Relationship of atomic numbers, atomic weights, and properties of the elements

2—Discussion of Periodic Table

(*a*) Valence changes
(*b*) Property changes
(*c*) Place of hydrogen and helium
(*d*) Place of rare elements
(*e*) Two families in a group

3—Advantages of Periodic Table

(*a*) Aid in classification
(*b*) Prediction of new elements
(*c*) Correlation of atomic weights
(*d*) Stimulating research

Phosphorus Group

1—Introduction

(*a*) Position in periodic table
(*b*) Contrast of their constants by table
(*c*) Contrast of their significant compounds
(*d*) Reference to nitrogen already studied

2—Phosphorus

(*a*) Occurrence
(*b*) Preparation
Industrial

(*c*) Properties
  Physical
  Chemical
(*d*) Allotropic forms
  White
  Red
(*e*) Uses
  Poisonous ingredients
(*f*) Compounds
  Chlorides: preparation, properties, and uses
  Oxides: preparation, properties, uses
  Acids
    Orthophosphoric: preparation, properties, test
    Metaphosphoric: preparation, properties, test
  Phosphides
    Hydrogen phosphide (phosphine): preparation and properties
    Calcium phosphide
    Sulfur phosphide
(*g*) Use of phosphorus in fertilizers

3—Arsenic

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties
(*d*) Compounds: oxides, halides, arsine, acids, sulfides, and sulfo acids
(*e*) Uses

4—Antimony

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties
(*d*) Uses
(*e*) Compounds: oxides, acids, and salts

5—Bismuth

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties
(*d*) Compounds: oxide, subchloride, subnitrate, and subcarbonate
(*e*) Alloys

Ionogens

1—Acids, Bases, and Salts

(*a*) General properties (review)
(*b*) Normal and molar solutions

2—Arrhenius' Theory of Ionization

(*a*) Indications that acids, bases, and salts ionize in aqueous solution: conductivity, osmotic pressure and boiling and freezing point alteration
(*b*) How Arrhenius' theory explains: electrolysis, conductivity and freezing and boiling point alteration

3—Action and Interaction of Ionogens

(*a*) Electronic conception of ionization
(*b*) Factors affecting degree of ionization
(*c*) Activity of acids and bases
(*d*) Full significance of neutralization

4—Chemical Equilibrium

(*a*) Factors affecting the speed of reaction
(*b*) Reversible reactions (kinetic explanation)
(*c*) Conditions under which reactions go to completion
(*d*) Factors affecting equilibrium: temperature, pressure, concentration, catalyst, common-ion effect
(*e*) Equilibrium relations in water
  Hydrolysis
  Hydrolysis of different types of salts

Sulfur Group

1—Introduction

(*a*) Reference to the study of sulfur as taken up in high school
(*b*) Manufacture of sulfuric acid (lead chamber process)
(*c*) Table showing similarity of sulfur to selenium and tellurium

2—Selenium

(*a*) Preparation
(*b*) Properties and uses

3—Tellurium

(*a*) Preparation
(*b*) Properties and uses

4—Silicon

(*a*) Introduction (similarity to carbon in respect to compounds)
(*b*) Preparation
(*c*) Properties
(*d*) Compounds: silica, silicic acid, silicon tetrachloride, water glass, and silicates

Halogen Group

1—Introduction

(*a*) History
(*b*) Position in periodic system
(*c*) Comparison of their constants

2—Preparations as Compared with Chlorine

(*a*) Bromine
(*b*) Iodine
(*c*) Fluorine

3—Properties

(*a*) Study the properties of bromine, iodine and fluorine as compared to chlorine
(*b*) Tests, as compared to chlorine

4—Uses of the Halogens

5—Compounds of Halogens (Bromine, Iodine and Fluorine as Compared with Chlorine)

(*a*) Hydrides: preparation, properties, and uses
(*b*) Salts: methods of formation and tests
(*c*) Oxides of chlorine
(*d*) Oxygen acids: hypochlorous acid and its salts, bleaching powder, and its use, chloric acid, perchloric acid, hypobromous acid, hypoiodous acid, bromic acid, iodic acid, and periodic acid
(*e*) Relative stability of oxygen acids

Reactions Involving the Structure of the Atom

1—Electronic Changes

(*a*) The dynamic and static atom
(*b*) Pairs of electrons
(*c*) Octet of electrons
(*d*) Polar and non-polar molecules
(*e*) Electronegativity
(*f*) Oxidation and reduction in terms of electrons
(*g*) Electrons and chemical equations
(*h*) Chemical stability of elements and compounds as illustrated by electronic changes of S, Mn, Cr, N

2—Electromotive Series and Electro Chemistry

(*a*) Factors determining the place of a metal in the electromotive series
(*b*) Electromotive force
(*c*) Electrical potential
(*d*) The significance of the electromotive series in chemistry
(*e*) The hydrogen electrode

(*f*) Measuring hydrogen-ion concentration
(*g*) Storage cell

Carbon Group

1—Introduction

(*a*) Review of work on carbon
(*b*) Table showing relation of carbon to silicon
(*c*) Reason for so many organic compounds
(*d*) Homologous series
(*e*) Electronic conception of valence as applied to organic compounds

2—Hydrocarbons: methane, ethylene, acetylene, petroleum, benzene, toluene

3—Derivatives of Hydrocarbons

(*a*) Alcohols: methyl, ethyl, and glycerine
(*b*) Aldehydes: formaldehyde and acetaldehyde
(*c*) Acetone
(*d*) Acids: formic and acetic
(*e*) Esters, fats, soaps
(*f*) Carbohydrates: sugars; cellulose
(*g*) Foods: vitamins; digestion; food values

Colloid Chemistry

1—Introduction

(*a*) What is meant by colloid chemistry
(*b*) Size of colloid particles
(*c*) What field is covered by colloid chemistry

2—Reasons for Colloidal Particles Not Settling Out

(*a*) Electrical charges
(*b*) Movement (Brownian)
(*c*) Protective film

3—Preparation

(*a*) **Condensation methods**
Formation by chemical replacement at low concentration of ions
Reduction
Hydrolysis
(*b*) Dispersion methods
Grinding
Electric arc methods
Emulsification
Peptization

4—Properties

(*a*) Dialysis
(*b*) Ultrafiltration
(*c*) Conductivity

5—Adsorption

(*a*) Charcoal
(*b*) Gels

6—Applications of Colloids

Metals

Two arrangements of the metals are provided—one based on the periodic classification, and the other according to qualitative analysis.

Periodic Classification

1—Introduction

(*a*) General properties of metals
(*b*) General occurrence
(*c*) Displacement series
(*d*) General processes of metallurgy

2—Group I: (Li), Na, K, Cu, Ag, (Au)

(*a*) Occurrence
(*b*) Preparation: Na, Cu, Ag
(*c*) Properties and uses
(*d*) Compounds:

Sodium: Na_2O_2, NaOH, NaCl, Na_2SO_4, Na_2SO_3, Na_2HPO_4, $NaNO_3$, $Na_2S_2O_3.5H_2O$, Na_2CO_3, $NaHCO_3$, $Na_2B_4O_7$. (Corresponding compounds of potassium)
Copper: CuO, $CuSO_4$, $Cu(NO_3)_2$, $Cu(OH)_2$, CuS, $Cu(NH_3)_4SO_4$, $CuBr_2$
Silver: AgCl, AgBr, AgI, $AgNO_3$, $Ag(NH_3)_2Cl$
Lithium: LiBr, Li_2CO_3

(*e*) Tests for each metal

3—Group II: Ca, Sr, Ba, Ra, Mg, Zn, Cd, Hg, (Be)

(*a*) Occurrence
(*b*) Preparation (Ca, Mg, Zn, Hg)
(*c*) Properties and uses
(*d*) Compounds:

Calcium: $CaCO_3$, CaO, $Ca(OH)_2$, $Ca_3(PO_4)_2$, $CaSO_4$, $CaOCl_2$ (Sr and Ba: corresponding compounds)
Magnesium: $MgCO_3$, MgO, $Mg(OH)_2$, $MgSO_4$
Zinc: ZnS, ZnO, $Zn(OH)_2$, $ZnCl_2$, $ZnSO_4$
Mercury: HgO, HgCl, $HgCl_2$, $HgNO_3$, $Hg(NO_3)_2$, HgS, $HgNH_2Cl$.

(*e*) Tests for each metal

4—Group III: (B), Al

(*a*) Occurrence
(*b*) Preparation (Al)
(*c*) Properties and uses
(*d*) Compounds: Al_2O_3, $Al(OH)_3$, $Al_2(SO_4)_3$, $K_2Al_2(SO_4)_4$, $Al(CH_3COO)_3$
(*e*) Tests for Al

5—Group IV: Sn, Pb

(*a*) Carbon and silicon (review or brief reference to periodic relations)
(*b*) Occurrence
(*c*) Preparation
(*d*) Properties and uses
(*e*) Compounds:

Tin: SnO_2, $SnCl_2$, $SnCl_4$
Lead: PbO, PbO_2, Pb_3O_4, $PbCl_2$, PbS, $PbSO_4$, $Pb(NO_3)_2$, $Pb(CH_3COO)_2$, $Pb_3(OH)_2(CO_3)_2$, $PbCrO_4$

(*f*) Tests for tin and lead

6—Group V

(*a*) Review N, P, As, Sb, Bi, and stress periodic relations
(*b*) Compounds:

Arsenic: As_2O_3, As_2O_5, AsH_3, As_2S_2, As_2S_3
Antimony: Sb_2O_3, Sb_2O_5, $(SbO)NO_3$, $SbCl_3$, $K(SbO)\ C_4H_4O_6$, $SbCl_3$
Bismuth: $BiONO_3$, BiOCl, $(BiO)_2CO_3 \cdot H_2O$

7—Group VI

(*a*) Review O and S and stress periodic relations
(*b*) Stress periodic relation of S to Se and Te
(*c*) Cr: Occurrence, preparation, properties, uses
Compounds:
Chromium: Cr_2O_3, $Cr(OH)_3$, CrO_3, K_2CrO_4, $K_2Cr_2O_7$, $PbCrO_4$
(*d*) Mo, W, U: uses
(*e*) Tests for Cr

8—Group VII

(*a*) Review halogens and stress periodic relationships
(*b*) Mn: Occurrence, preparation, properties, uses
Compounds: MnO_2, K_2MnO_4, $KMnO_4$
(*c*) Tests for Mn

9—Group VIII: Fe, Co, Ni, (Pt)

(*a*) Occurrence

(*b*) Preparation
(*c*) Properties
(*d*) Compounds:
Iron: $FeCl_2$, $FeCl_3$, Fe_2O_3, Fe_3O_4, $Fe(OH)_3$, FeS, $Fe(OH)_7$, $K_2Fe_2(SO_4)_4$
Cobalt: $CoCl_2.6H_2O$, $Co(OH)_2$, $CoSO_4$, CoS
Nickel: $NiSO_4$, $Ni(OH)_2$, NiS

10—Group O, the Inert Gases, He, Ne, Ar (Kr, Xe, Rn)

(*a*) Discovery
(*b*) Occurrence
(*c*) Properties and uses

Qualitative Analysis

1—Introduction

(*a*) General properties of metals
(*b*) General occurrence
(*c*) Displacement series
(*d*) General processes of metallurgy

2—Hydrochloric Acid Group: Ag, Hg, Pb

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties and uses
(*d*) Compounds:
Silver: $AgNO_3$, AgCl, AgBr, AgI, $Ag(NH_3)_2Cl$
Mercury: HgO, HgCl, $HgCl_2$, $HgNO_3$, $Hg(NO_3)_2$, HgS, $HgNH_2Cl$
Lead: $PbCl_2$, $Pb(NO_3)_2$, $Pb(CH_3COO)_2$, PbS, $PbSO_4$, $PbCrO_4$, $Pb_3(OH)_2(CO_3)_2$, Pb_3O_4, PbO, PbO_2
(*e*) Tests and reactions of each metal
(*f*) Qualitative analysis of group

3—Hydrogen Sulfide Group: Hg, Pb, Bi, Cu, Cd, As, Sb, Sn

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties and uses
(*d*) Compounds:
Mercury: as in above
Lead: as in above
Bismuth: $BiONO_3{\cdot}H_2O$, BiOCl, $(BiO)_2CO_3{\cdot}H_2O$
Copper: CuO, $Cu(OH)_2$, $CuSO_4$, $KCu(CN)_2$, CuS, $Cu(NH_3)_4SO_4$, $Cu(NO_3)_2$, $CuBr_2$
Arsenic: previously studied (review) As_2O_3, As_2O_5, AsH_3, As_2S_3, As_2S_5
Antimony: $SbNO_3$, $SbCl_3$, Sb_2O_3, Sb_2O_5, K(SbO), $C_4H_4O_6$, SbH_3, $SbONO_3$
Tin: SnO_2, $SnCl_2$, $SnCl_4$
(*e*) Tests and reactions of each metal
(*f*) Qualitative analysis of group

4—The Ammonium Sulfide Group: Al, Cr, Fe, Mn, Zn, Co, Ni

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties and uses
(*d*) Compounds
(*e*) Tests and reactions of each metal
(*f*) Qualitative analysis of the group

5—Alkali Earth Group: Ca, Sr, Ba

(*a*) Occurrence
(*b*) Preparation
(*c*) Properties and uses
(*d*) Compounds:
Calcium: $CaCO_3$, CaO, $Ca(OH)_2$, $Ca_3(PO_4)_2$, $CaSO_4$, $CaOCl_2$, $Ca(CH_3COO)_2$
Strontium: $Sr(OH)_2$, $Sr(NO_3)_2$, $SrBr_2$, $SrSO_4$, $Sr(CH_3COO)_2$
Barium: $BaCl_2$, $Ba(OH)_2$, BaO, BaO_2, $Ba(NO_3)_2$, $BaSO_4$, $BaCrO_4$, $Ba(CH_3COO)_2$
(*e*) Tests and reactions of each metal
(*f*) Qualitative analysis of the group

6—Alkali Group: Mg, Li, Na, K, Include NH_4

(*a*) Occurrence
(*b*) Preparation (Na)
(*c*) Properties and uses
(*d*) Compounds:
Magnesium: $MgCO_3$, MgO, $Mg(OH)_2$, $MgSO_4$
Sodium: $NaOH$, Na_2O, Na_2O_2, Na_2SO_3, Na_2S, Na_2HPO_4, $NaNO_3$, $Na_2S_2O_3$, $NaCl$, Na_2SO_4, Na_2CO_3, $NaHCO_3$, $Na_2B_4O_7$, $NaClO_3$
Potassium: Show the similarity of potassium compounds to the corresponding sodium compounds
Ammonium: NH_4Cl, $(NH_4)_2CO_3$, $(NH_4)_2SO_4$
Lithium: $LiBr$, Li_2CO_3
(*e*) Tests and reactions of Mg, Na, K, NH_4
(*f*) Qualitative analysis of group

7—Qualitative Procedure When Groups (of Important Metals) Are Mixed

8—Qualitative Analysis of the Common Acid Radicals

9—The Inert Gases: He, Ne, Ar (Kr, Xe, Rn)

(*a*) Discovery
(*b*) Occurrence
(*c*) Properties and uses

The committee wishes to reiterate and to emphasize that it is not the purpose of the foregoing syllabi to "standardize" the teaching of chemistry. The committee would consider any such result of its labors as a misfortune, indeed. If, however, a course in high-school chemistry can be made to mean something definite which the colleges may take for granted in the same way that they do high-school English and mathematics, for instance, and if unnecessary duplication of effort can be eliminated to an appreciable extent, much will have been accomplished.

The present outline is submitted with no illusions that it is either perfect or final. Perhaps at the present moment it leaves much to be desired. Certainly the growth of the science will necessitate its revision from time to time. The committee invites criticism and suggestions leading to the further improvement of the outline.

NEIL E. GORDON, *Chairman*
B. S. HOPKINS
L. W. MATTERN
L. C. NEWELL
R. E. ROSE
W. SEGERBLOM
D. B. KEYES
R. E. SWAIN
T. G. THOMPSON
F. W. WILLARD
F. B. WADE
GEO. L. COYLE

Nothing great in science has ever been done by men, whatever their powers, in whom the Divine afflatus of the truth-seeker was wanting.—HUXLEY

REPORT OF THE SECRETARY OF THE DIVISION OF CHEMICAL EDUCATION AND SENATE OF CHEMICAL EDUCATION

A special meeting of the Senate of Chemical Education was called to order by Dr. Neil E. Gordon at 10 A.M., Monday, April 11th, Hotel Jefferson, Richmond, Va.

Dr. Gordon outlined the development of the idea of an Institute by the Committee of Chemical Education and the Senate of Chemical Education since the summer of 1925.

General discussion followed. . . . . .

Moved (Matthews) and seconded (Baker) that the following resolution be submitted to the Council of the A. C. S.:

The A. C. S. Committee of Chemical Education, in coöperation with the Senate of Chemical Education, moves that the Council of the American Chemical Society approve the establishment of an Institute for Chemical Education with the understanding that all plans, including the method of the appointment of the Board of Trustees, the ways and means of financing, the type of organization, the location of the Institute and its relation to the coöperating institute or institutions be submitted to the Council by the Senate and Committee of Chemical Education before any definite action is taken.

Carried.

The Secretary was authorized to have a picture of the Senate taken Tuesday and to arrange for a luncheon immediately following.

Adjourned, 12:15 P.M.

* * * * *

The regular meeting of the Senate of Chemical Education was called to order by the Chairman, Dr. Neil E. Gordon, at 9 A.M., Tuesday, April 12th, Hotel Jefferson, Richmond, Va.

The minutes of the special meeting of April 11th were read and approved.

Dr. Gordon reported the action of the Council in referring the Senate resolution to its Executive Committee.

Moved (Billings) and seconded (Brautlecht) that the minutes of the special and regular meetings April 11th and 12th be mimeographed and sent to all Senators and that the resolution which was presented to the Council be published in the JOURNAL OF CHEMICAL EDUCATION. Carried.

Moved (Hopkins) and seconded (Hessler) that the Senate advise the Committee on Chemical Education to coöperate with and support the Institute conducted at Penn. State during the summer of 1927 as an experiment in connection with an Institute of Chemical Education.

Moved (Newell) and seconded (Whiteford) to request the Committee on Chemical Education to seek an early opportunity to confer with the

Executive Committee of the A. C. S. concerning the question referred to the latter by the Council. Carried.

The special Committee appointed at the Philadelphia meeting to consider the reorganization of the Senate, presented its report. The following features were adopted.

1. Membership in the Senate shall be limited to members, in good standing, of the A. C. S.

(*a*) There shall be one industrialist, one college teacher, and one high-school teacher from each state, chosen as at present by recognized organizations within these states.

(*b*) The members of the Committee on Chemical Education of the A. C. S. shall be *ex officio* members of the Senate.

(*c*) The Chairman and Secretary of the Division of Chemical Education shall be *ex officio* members of the Senate.

(*d*) Past Chairmen of the Division and Senate for the three years immediately preceding shall be *ex officio* members of the Senate.

2. The terms of office of State Senators shall be three years, and shall be staggered so that one member will be elected each year.

3. Substitutes shall be appointed by the organization charged with the original selection, or its executive committee.

4. The Senate shall be considered the official body of the Division of Chemical Education, in order to leave more time for the reading of papers before the latter.

5. A quorum shall be the entire Senate; issues to be decided by the letter ballot by a majority of those voting.

It was voted that any member of the Senate could propose measures for discussion and action by the Senate.

The Committee on Chemical Education reported the results of the national survey of laboratory equipment, library facilities, and preparation of teachers of chemistry in the high schools of the country. Dr. Gordon was requested to publish a summary of the report in the JOURNAL OF CHEMICAL EDUCATION.

Dr. Neff described the coöperation of the Northeastern Section with students and teachers of chemistry in its area.

A rising vote of thanks was tendered Dr. Gordon for his services as Chairman, *ex officio*, of the Senate.

Adjourned 11:45 A.M.

* * * * *

The following Senators attended the Richmond meeting of the American Chemical Society:

Edgar B. Carter (proxy for Frank B. Wade), H. W. Rhodehamel, Norris W. Rakestraw, Leonidas R. Littleton, John C. Hessler, G. H. Whiteford, F. B. Dains, Lyman C. Newell, Wilhelm Segerblom, B. S. Hopkins, O. L. Shinn, Erle M. Billings, Percival Robertson (proxy for Herman Schlundt), L. McMaster (proxy for C. W. Cuno), William Foster,

J. N. Swann, E. M. Shelton, Friend E. Clark, J. Sam Guy, A. L. Ferguson (proxy for O. E. Madison), C. A. Brautlecht, R. N. Maxson, Joseph S. Chamberlain, R. E. Rose, Gustavus J. Esselen, Jr., P. Conant Voter, R. A. Baker, Neil E. Gordon, F. W. Willard, Wm. L. Evans (proxy for William McPherson), J. H. Matthews, L. B. Lockhart, R. R. Thompson.

* * * * *

The regular business meeting of the Division of Chemical Education was called to order by Chairman B. S. Hopkins at 4:30 P.M., Thursday, April 14, 1927, 2nd Baptist Church, Richmond, Va.

The recommendations for reorganization submitted by the Senate (published in the report of the regular Senate meeting) were read and approved.

The Chairman was authorized to appoint a representative committee to formulate five or six outstanding problems in chemical education, each problem to be assigned to a special committee for study and report.

The following committee was duly appointed: Wilhelm Segerblom, *Chairman*, J. C. Hessler, A. J. Currier, L. R. Littleton, G. H. Whiteford.

The Committee on Research on Problems of High-School Chemistry Instruction presented its fourth report as follows:

(1) Your Committee has held the plates on a number of investigations published in the JOURNAL OF CHEMICAL EDUCATION. It hopes to be able to reprint all of these and others to be published on related subjects under one cover for use in courses in the teaching of high-school chemistry and for promoting further investigational work.

(2) Your Committee has found the following unpublished reports in university libraries and is taking steps to give them adequate publicity.

BRYSON, OLIVE FLORA, "The Extent to Which Diagrammatic Drawings Contribute to the Understanding of Scientific Facts," University of Chicago, 1921.

GERRY, HENRY LESTER, "A Test of High-School Chemistry," Harvard University, 1923.

RICH, STEPHEN G., "Standardized Tests in Chemistry Relative to Social Aims of Instructional Results," New York University, 1923.

ECKERN, RAMONA, "A Textbook in Mathematics for First-Year Chemistry and Physics Students," Stanford University, 1922.

SCHAFER, CHAS. HENRY, "High-School Chemistry Marks—How to Determine Them, and Their Significance to University Chemistry Departments," Teachers' College, 1923.

HURST, PHILIP HARRISON, "Trends in the Content and Methodology of Chemistry in Secondary Schools since 1875," University of Southern California, 1925.

BRIGHT, LESLIE O., "An Analysis of the Visual Aids Used in High-School Chemistry Texts," University of Illinois, 1925.

NAUMAN, ROBT. HENRY, "The Use of Objectives in Teaching High-School Chemistry," University of Illinois, 1925.

LYNCH, MARGARET WINIFRED, "Psychological Tests Applied to Chemistry Teaching," Boston University, 1924.

BEATTIE, ALFRED WESLEY, "Objective Standardized Tests and Informal Tests in Chemistry," University of Pittsburgh, 1924.

RANTZ, FREDERICK ALBERTSON, "Measuring the Results of Teaching in Chemistry," University of Washington, 1925.

ANIBAL, FRED G., "A Comparison of Lecture Demonstration and Individual Laboratory Methods of Teaching High-School Chemistry," University of Chicago, 1924.

KNOX, WILLIAM WARREN, "The Demonstration versus the Laboratory Method of Teaching High-School Chemistry," University of Texas, 1925.

PRUITT, CLARENCE, "An Experiment of the Relative Efficiency of Methods of Conducting Chemistry Laboratory Work," Indiana University, 1925.

LYONS, FRANCES WARNER, "Contribution of Chemistry to Conduct Control for Boys and Girls of the High-School Group," University of Pennsylvania, 1925.

BATE, LANGSTON FAIRCHILD, "An Analysis of High-School Textbooks in Chemistry," University of Chicago, 1923.

MATES, JAMES WILSON, "To Determine a Basic List of Chemical Terms for the Use of High-School Students," University of Pittsburgh, 1925.

The report was accepted and the Committee was requested to submit an estimate of the cost of printing and binding the proposed reprints. The Committee on Research on Problems of College Chemistry Instruction presented the following report:

The activities of your committee have for the past month been directed toward a definition of pressing problems in this field. They may be classified as follows:

1. Articulation of college with high-school chemistry.

It is quite in vain to say that high-school chemistry may be ignored and that students are better prepared for college work if they have not had high-school chemistry. Data at hand furnish quite convincing evidence that chemistry teaching in some high schools is as effective as chemistry teaching in many colleges and that chemistry teaching in some high schools and in some colleges is quite ineffective. In other words there is an enormous range in difference between the work done in different schools. The problem of articulating with high-school work is complicated by the enormous range of individual differences in students to profit from instruction. The scheme of classifying college students into groups on the basis of whether they have or have not studied chemistry in high school is quite inadequate. The use of placement tests seems to offer the most promising scheme for adjusting to this important problem and your Committee solicits your encouragement to give intensive study to this problem.

2. Differentiation to meet vocational needs.

Chemistry is so broad in its scope that is has seemed necessary for students to begin to specialize early in their period of training. It is clear that, sometime in the period of training, agricultural chemists should be differentiated from chemical engineers, pre-medics and students of home economics, dentists, etc. Should this differentiation be made at the beginning of the college career or at some time later? If at a later time, when? Answers to these questions will be revealed through an analysis of the different vocations to determine what chemistry is useful to the workers that follow them. The competition is so keen in the scientific professions that the period of training is necessarily long. In order to conserve the student's time we owe it to him to arrange the work in chemistry so that there will be a minimum of lost time and energy. The colleges are overcrowded and in the interest of efficiency it behooves us to use the

college plant so that there will be a minimum of waste. Evidence from casual observation is convincing that the waste in chemistry teaching is too large—larger than could be tolerated in an industrial plant. A careful survey would reveal this and suggest remedies. Your committee solicits your encouragement to study this problem. The study will take the form of an analysis of one or two vocations.

3. The problem of guidance. *Agriculture.*

The welfare of chemistry demands that we provide some scheme for giving recognition to students with interest and aptitude for work in this field. The traditional methods of assigning marks to large classes on the basis of the antiquated essay examination is quite inadequate and is attended by gross injustice. With the development of new types of tests there is at hand a method for rating ability which is quite superior to the one which is used in present practice. Your committee has assembled and analyzed examination questions from several of the leading institutions and the results reveal a great variation in practices. Your committee solicits your encouragement to give intensive study to this problem.

4. The problem of method.

There is probably nothing that we talk more and know less about than methods. We depend upon hunches for guidance and this is quite unbecoming of scientists trained in the use of the scientific attributes. Methods refer to how to do things. We shall be able to evaluate methods more intelligently if different methods are defined and the problems of method identified. An intensive study of methods will reveal these and your committee would like encouragement.

(Professor Newell's remarks.) "These are apparently the major problems of college chemical education. Intensive study of these will no doubt reveal others. In our preliminary work it is important that we direct our attention to the work which will be most directly applicable to meeting present needs, yet in this endeavor, as in the field of pure science, we must not over-emphasize the practical. Let us enter this field of research with a determination to reveal the facts about our field. With a body of factual material before us we may have faith that the facts will be useful. This body of factual material cannot be assembled by chemists with whom the problems are side issues. They require intensive study and the Society should attempt to make it worthwhile for some chemists who have training in the methods of educational research to devote their time to intensive study of them."

The report of the committee was accepted and referred to the Senate for such steps as it might care to inaugurate.

The Chair was authorized to appoint an Assistant Secretary.

The Secretary was directed to write the Richmond Section expressing the appreciation of the Division for the coöperation of the Section and its representatives during the meeting.

Dr. Clarke of Michigan State College invited the Division to visit the new Chemistry Building of his institution at the time of the Detroit Meeting. He described various novel features of the building.

Approval was given to the general plan to make an excursion from Detroit to East Lansing during the Detroit Meeting.

Adjourned 5:30 P.M.

R. A. BAKER,
Secretary

Healthy and Cancer Tissue Give Different Kinds of Light. Studying the light given off by ash of tumors burned in an arc light is the latest method of attacking the cancer problem, one which has been applied at the Hahnemann Medical College at Philadelphia by a trio of biologists and a physicist, Donald C. A. Butts, Thomas E. Huff, and Frederick Palmer, Jr. By means of a spectroscope, which analyzes the light, and reveals the elements that cause it, they have found that the yellow lines due to sodium, and which appear only momentarily when the ash of normal animal tissue is placed in the arc, persist until it has all been consumed when the ash from tumors is analyzed. This shows the presence of the element sodium in cancerous tissue.—*Science Service*

Starch from Canna Roots, New Hawaiian Industry. Pineapples and sugar are the two principal industries of Hawaii, but a third is rapidly being established to make use of lands too wet for pineapples and too high for cane. This is starch, to be made from the edible canna. For fifty years Australia has furnished the market with arrow-root, which is starch from the root-stock of this plant. The familiar canna of our gardens has tubers rich in starch but the edible species has a very much larger spread of underground stems filled with starch that is easily separated from the fiber for market use. Hawaii has used the plant extensively for stock feeding and there seems no reason why it should not be very profitable for commercial use when established.—*Science Service*

Leopard Changes Spots at Will of Chemist. The leopard can have his spots changed, at least after he is dead, and any other fur-bearing animal can be similarly metamorphosed by the magic of the dye chemist, to meet the demands of fashion. At the Richmond meeting of the American Chemical Society, William E. Austin of New York spoke on the importance of this industry to the modern fur trade.

"In spite of the great variety of furs, and the difficulties involved in the dyeing operations, it is now possible to produce on furs effects such as could be made formerly on textile fabrics only, such as printing, etching, stencil work, multicolored effects and so on," said Mr. Austin. "Bleaching has been successfully developed and applied. Naturally dark furs can now be dyed in light colors similar to those hitherto obtained only on white furs. In the very near future black furs will be made white on a commercial scale."—*Science Service*

Studies Effects of Paints on Health-Giving Sun Rays. The effects of various oils and other paint materials on ultra-violet rays, which have recently attracted much attention because of their newly discovered importance in medicine, have been the subject of study by George F. A. Stutz of Washington, who spoke before the recent meeting of the American Chemical Society. The degree to which the rays are absorbed by linseed oil, the old standard paint vehicle, seems to depend in part on what has been done with it beforehand. Boiled oil absorbs the radiation entirely at the surface, whereas raw oil permits it to penetrate a considerable distance before it is completely extinguished. Oil dried by exposure to ultra-violet light is more opaque to the light afterward than is oil dried in diffuse daylight. Lacquer films, it was found, permitted a considerable penetration of the rays.—*Science Service*

THE INSTITUTE OF CHEMISTRY OF THE AMERICAN CHEMICAL SOCIETY

A chemical vacation community organized for the intensive study of all branches of chemistry and for daily conferences on the recent advances in the science and its applications in industry is being planned by the American Chemical Society to be held at The Pennsylvania State College during the month of July. Its program will appeal to chemists in industry, to teachers of chemistry in all grades, to physicians, and to the non-chemical public. It will be based on the success of the round-table on "Chemistry in World Affairs," which was a part of the Institute of Politics at Williamstown last summer.

This Institute of Chemistry is in charge of a committee composed of G. L. Wendt, State College, Pa., F. C. Whitmore, Evanston, Ill., W. R. Whitney, Schenectady, N. Y., C. M. A. Stine, Wilmington, Del., C. E. K. Mees, Rochester, N. Y., F. W. Willard, New York City, B. S. Hopkins, Urbana, Ill., and N. E. Gordon, College Park, Md. The Institute will meet for four weeks—July 4th to 30th. Those who desire college credit for courses taken in connection with the Institute will attend for the six weeks of the regular summer session—June 28th to August 6th.

There will be four chief items in the program. The daily conferences on "1927 in Chemistry" will meet each day at eleven, and periods of one to four days will be devoted to such subjects as catalysis, colloids, thermodynamics, X-rays, crystal structure, chemical engineering economics, chemical education, physical chemistry of alloys, distillation, vitamins and deficiency diseases, electron phenomena, atomic structure, and others. They will form in effect a series of symposia on the theory and its application in other sciences, in the industries, and in education. The detailed program has not yet been arranged.

In addition to attendance at conferences each member of the Institute will have the opportunity of attending one or more of the intensive courses given by leaders in chemical research and development of this country and Europe. A third feature of the program will be the evening lectures which will be both advanced and popular, in two different series. The last but not least important item will be the opportunities for recreation provided to members. The afternoons will be left free. There will be no scheduled meetings on Saturdays and Sundays. There will thus be time for informal discussion groups, excursions in the mountains, golf, tennis, and fishing, and automobile trips through the scenic forests and mountains of Pennsylvania.

Foreign Speakers

Four European chemists will be present for part or all of the session and will take part in all phases of the program. Dr. Eric K. Rideal of Cam-

bridge University, England, will have charge of a portion of the work in catalysis. Professor J. C. Drummond of University College, London, will present special topics in biological chemistry. Dr. Jean Piccard of the University of Lausanne, Switzerland, will have charge of the course in advanced organic chemistry. Dr. Hans Tropsch of the Coal Research Institute at Mühlheim-Ruhr, Germany, will discuss the recent work in the catalytic production of synthetic motor fuel and other chemical products from coal.

Other speakers who will have charge of courses and conferences will include Dr. James Kendall, F.R.S., of New York University, Dr. Harry N. Holmes of Oberlin College, Dr. Wheeler P. Davey of the Pennsylvania State College, Dr. H. S. Taylor of Princeton University, Dr. Victor Cofman of the du Pont Company, Dr. L. H. Germer of the Bell Telephone Laboratories, Dr. L. Tonks of the General Electric Research Laboratories, Dr. C. H. Kunsman of the Fixed Nitrogen Research Laboratory, Dr. Marie Farnsworth of New York University, Dr. C. P. Smyth of Princeton University, Dr. E. P. Carr, Mt. Holyoke College, F. C. Whitmore, Northwestern University, and members of the faculty of the Pennsylvania State College, R. A. Dutcher, W. R. Ham, D. C. Duncan, E. D. Ries, G. C. Chandlee, and G. L. Wendt. The courses of lectures given by these men include advanced inorganic chemistry, theories and practice of analytical chemistry, advanced organic chemistry, physical chemistry, advanced physical chemistry, X-rays and crystal structure, colloids, catalysis, atomic structure, thermionic and photo-electric phenomena, optics, electrical measurements, applied thermodynamics, clinical and biochemical methods, and vitamins and deficiency diseases. A course in the teaching of chemistry will be given by a professor selected by the committee on chemical education of the American Chemical Society. In addition to these courses the usual undergraduate courses in chemistry will also be given, including elementary organic chemistry, household chemistry, quantitative analysis, qualitative analysis, elementary chemistry for chemists, elementary chemistry for students in engineering, and a course combining chemistry and physics for students in education and the liberal arts. All courses in chemistry and physics will be open to members of the Institute, who will, in general, choose one of these courses for intensive study, while all members will attend the daily conferences.

A group of modern fraternity houses has been reserved for the exclusive use of the institute and will form a separate campus. Opportunity for discussion and for extensive acquaintance will be given by this community of living. Rooms will be assigned in these Institute dormitories as applications are received, several buildings being reserved for women members and for members who bring their wives or husbands. A uniform charge of $15.00 a week will be made for board and room in these dormitories. The fee for membership in the Institute, which will include admission

to all courses and lectures and will be used to defray the program expenses, will be $10.00 for one week, $20.00 for two weeks, $25.00 for three weeks, and $30.00 for four weeks. College credit up to six semester hours is included in the $30.00 fee, but six weeks are needed for credit. Members of the Institute and their families will also be interested in the full program of lectures and entertainments given by the Summer Session of the Pennsylvania State College which will be in session at the same time. These include lectures by Dr. H. V. Pike, Grace Hazard Conkling, Clayton Hamilton, Edward Davison, Dr. F. L. Pattee, and Hamlin Garland. There will be recitals and concerts by Stella Anderson, Vera Poppee and James Woodside, and dramatic performances by the Penn State Players, the DeVereaux Players, and by U. L. Granville. The institute of French Education, under M. G. P. Fougeray, will have a number of interesting French sessions, including lectures by M. Des Granges. There will be numerous excursions to the mountains and forests under the direction of the Department of Nature Study.

The detailed calendar of the daily conferences will be announced so that it will be possible to plan attendance for a portion or the entire session. The conferences will be opened by Dr. George D. Rosengarten, President of the American Chemical Society, and the presiding chairmen will be the members of the directing committee listed above and others. The general chairman will be Dr. H. E. Howe, Editor of *Industrial and Engineering Chemistry*.

Detailed information, housing reservations, and a special bulletin may be obtained by writing to G. L. Wendt, Director, Institute of Chemistry, State College, Pa.

Nicotine Has Rival in Insecticide Field. Nicotine, thus far practically unrivalled as an insecticide against plant lice, may soon have a serious competitor in the field through the results of experiments carried on at the U. S. Bureau of Entomology.

An oil prepared from pyridine, which forms an essential part of nicotine, combined with sodium, has been found to be poisonous to plant lice. Like nicotine it destroys the lice without injuring the infested plants. Entomologists believe it possible that dipyridyl oil, as the new compound is called, may prove more effective than nicotine for the practical control of some injurious insects.

Thus far the economic phase of large-scale production of the new insecticide has not been thoroughly gone into, but it is believed that it can be made as cheaply as nicotine. Pyridine is obtained from coal-tar distillation as a by-product and is largely wasted. The supply is great and the demand small so that it is fairly cheap. Sodium may also be obtained at low prices. The cost of the new product should, therefore, not exceed the cost of nicotine. Entering into the field as a rival, it may possibly bring down the price of nicotine.

It is difficult to find chemicals possessing sufficient toxicity to destroy plant lice and, at the same time, not injure the plants. The bureau experimented with sixteen other organic compounds whose toxicity was inferior as compared to dipyridyl oil.—*Science Service*

Chemical Digest

LISTER CENTENNIAL

On Wednesday, the fifth of April, England celebrated the hundredth anniversary of the birth of Sir Joseph Lister, the great surgeon to whom we owe the introduction of antiseptic methods in the practice of surgery. The celebration took place at the Royal College of Surgeons and at Westminster Abbey. A centenary program will also be given in Edinburgh during the week of July 15th–23rd in connection with the ninety-fifth annual meeting of the British Medical Association. Lord Lister's manuscripts, instruments, and other relics will be on view in the library of the University of Edinburgh. Lord Balfour and Sir Watson Cheyne will preside over a public meeting on July 20th at which representatives from the University of Paris, Harvard, and Nova Scotia will deliver addresses. The American Association for Medical Progress, Inc., lists the following interesting events in the life of Lord Lister:

Born at Upton House in West Ham, Essex, England, April 5, 1827. Died February 10, 1912, of pneumonia; body in Westminster Abbey.

Educated as a boy at a Quaker school at Tottenham near London.

In 1844 entered University College, London, at the age of 17, as a student in arts.

Attended the medical school at University College Hospital and won two gold medals.

Took his B.A. degree at the University of London, 1847.

Graduated 1852 from the University of London, with an M.D. degree, having specialized in surgery.

Began career as house surgeon to Sir John Erichsen at University College Hospital. Had charge of certain cases during a gangrene outbreak.

In 1852, at 25 years of age was a Fellow of the Royal College of Surgeons.

Became Professor of Surgery at University of Glasgow, 1860.

In 1864 began work on "Antiseptic" system; March, 1867, wrote first paper on "Antiseptic Surgery."

Published papers giving his views on the use of carbolic acid as a preventive of infection in surgery, in 1867.

Accepted Professorship of Clinical Surgery at Edinburgh, 1869, succeeding Professor Syme.

By 1875 was internationally famous; made a tour on the Continent in 1875, and was given honorary receptions in Munich and Leipzig.

In 1876 read paper before section of Surgery at the International Medical Congress, at the Centennial Exposition in Philadelphia; after that his system received increasing application in America. First used by Dr. W. W. Keen, in Philadelphia.

In 1877, appointed Professor of Surgery at King's College, London.

In 1880, degree of LL.D. conferred upon him by Cambridge and Oxford Universities.

In 1880, received the Gold Medal of the Royal Society.

Introduced absorbable ligatures (catgut) in 1880.

1883, made a baronet.

1886, appointed on the British Government Commission to study the prophylaxis of hydrophobia by Pasteur's method.

1892, delegate from Great Britain to Pasteur's jubilee in Paris.

From 1895–1900 was President of the Royal Society.

1897, made a peer of the realm, as Baron Lister of Lyme Regis.

The following outline of Lister's work is also quoted from material sent out by the American Association of Medical Progress, Inc.:

Before Lister's experiments, a large proportion of all kinds of wounds were fatal. In amputation and other extensive operations, suppuration or festering would set in, resulting often in "blood poisoning," and also often interfering with healing of the blood vessels, so that the patients would bleed to death. In former times the fever which accompanies the septic process and the festering itself were supposed to be necessary parts of natural healing. Lister established beyond all question that suppuration is not only unnecessary, but is the preventable cause of most of the deaths following certain serious wounds, and of the deaths following many kinds of surgical operations. Hospital gangrene had become very common and was accepted as part of the risk of surgery in hospitals. Lister was impressed by the suffering and the large proportion of deaths. He noted especially the great disproportion of deaths in cases of compound fractures—that is, breaks in which the bones are exposed, or in which the skin is ruptured. The best protection, Lister observed, is an unbroken skin; but the reason for this was supposed to be in the fact that the air in some way caused suppuration, which is really a putrefaction or decay of the tissues.

Lister was first brought to a new way of considering the problem by reading one of Pasteur's papers, in which fermentation and putrefaction were shown to be related to the presence of minute living "germs" rather than to the gaseous parts of the air itself. Lister thereupon proceeded to experiment on his own account, using flasks with long bent necks, arranged so that air might readily come in and out, but not any floating particles that might be present in the air. He showed, as had Pasteur before him and John Tyndall at about the same time, that fluids quite capable of putrefaction could be kept indefinitely, exposed to air, so long as the "germs" were kept out. He concluded that the way to prevent festering of wounds or surgical openings was by keeping the germs out.

His next problem then was to exclude infections, and he tried various plans to cover, or protect wounds, all without success. Once he learned of the use of carbolic acid for treating the sewage of Carlisle, in England, to overcome the foul odors. He rightly concluded that the carbolic acid, which is a violent poison, was useful in treating sewage because it prevented further putrefaction, and he resolved to try it for preventing suppuration in wounds. He accordingly applied dressings soaked in carbolic acid in cases of compound fracture, where it had become customary to amputate limbs, and attained remarkable success in saving not only the limbs, but also the lives of the victims, since amputations had always yielded a large proportion of fatalities.

Later he extended the use of these "antiseptic" dressings to abscesses, and finally to surgical wounds. He would soak his instruments and the area on which he was to operate in diluted carbolic acid, and keep the working surface covered with lint or cotton containing the antiseptic fluid. His success was in striking contrast to the continuing excess of deaths in the surgical hospitals using older methods.

Another serious problem with which Lister concerned himself was that arising from the system used for closing wounds. He had observed that a bit of metal or glass

might be included within the body for an indefinite length of time, without causing trouble, whereas a bit of thread (used for stitching wounds) almost always led to inflammation or festering, and interfered with healing. He suspected that this was due to the presence of germs in the pores of the thread, and decided to make sure by means of definite and conclusive experiments. For this purpose he went to the Veterinary School at Toulouse, in France, and here he sewed together the cut ends of blood vessels in horses, with threads that had been soaked in solutions of carbolic acid. The wounds were closed at once, and healed promptly, without inflammation or pus, without fever, without complications. Later the wounds were examined to make sure that all conditions were favorable to the welfare of the experimental animals. Only after these successful experiments did Lister undertake to use the same methods on human patients, and he remedied conditions that would have been perfectly hopeless under the older practices.

His third great contribution to surgery was the experimental solution of the problem of suitable materials for sewing up breaks in human tissues. These experiments were made on healthy calves and led to the substitution of "catgut" for silk; and this has been used ever since (nearly sixty years) in practically the same way as Lister had worked out. The catgut can be absorbed in the course of time, whereas silk or linen remains as a possible center of irritation or of abscess formation.

"The surgical revolution of the last thirty years," wrote the great American Surgeon, W. W. Keen, in 1910, "is the most momentous in the entire history of surgery. In every science—chemistry, engineering, botany, physics, electricity—the era of precise experiments has been the era when enormous and constant progress has been made. Medicine is no exception. We have closely studied disease by various observational methods, and clinical observation for two thousand years has slowly advanced our knowledge up to a certain point. Then experimental research, which employed methods of precision, varying conditions at will, noting the different results, and multiplying the experiments at will instead of waiting it might even be years, until Nature's second experiment occurred, began its work; and in the past thirty years experimental research has produced a more fruitful harvest of good to animals and to mankind than the clinical observation during thirty preceding centuries."

As a result of Lister's work we have not only the vast improvement and extensions of surgery into fields that were formerly inaccessible, such as abdominal, chest, and brain surgery, but a ready control of wound infection, which was formerly a serious source of suffering and even of death. There have of course been great improvements in the application of Lister's principles, but the prevention of infection is a permanent addition to our defense against injurious bacteria. W. R. W.

ANNIVERSARIES OF SCIENCE

The following anniversaries of science appear among those listed by *Science Service* during the past two months:

Michael Faraday was appointed assistant in the laboratory of the Royal Society, under Sir Humphry Davy, on March 1, 1813. We quote the following from H. A. Bumstead in "Development of the Sciences:"

Great as is the debt which electrical science owes to Ampere, it is exceeded by its obligation to Faraday whose marvelous experimental skill and instinctive perception

of the inner nature of phenomena are still the wonder and admiration of all men of science. At twenty-one years of age he was a journeyman bookbinder, who had educated himself in some degree by reading the books which he was given to bind. The Encyclopaedia Britannica aroused his interest in science and he applied to Davy for employment in the Royal Institution. For a number of years, as Davy's assistant, his chief work was in chemistry; but Oersted's discovery turned his thoughts toward electricity and thereafter it was his principal field of work. In 1831 he made the capital discovery of the introduction of currents, which is not only of the most fundamental consequence to the theory of electromagnetism but is the foundation of the innumerable practical applications of electricity to the uses of man.

Alexander Volta, inventor of the voltaic battery, died March 5, 1827. Bumstead in "Physics in the Development of Science" writes:

In 1791 Galvani, professor of anatomy at Bologna, gave an account of his experiments on the contraction of frog's legs when touched with two different metals in series and, with much ability, supported the view that it was an electrical manifestation. He naturally supposed that the origin of the electrical disturbance was in the animal tissues. This was combated a year later by Volta, who referred the seat of the forces involved to the point of contact between the dissimilar metals, and gave good evidence that they were electrical. The effects, however, were very small, and interest flagged until 1800, when Volta invented the "pile," by means of which very appreciable results could be obtained. This at once excited much attention; and in the same year Nicholson and Carlisle in England in experimenting with the Voltaic pile observed the decomposition of water by electrolysis and, shortly afterwards, Sir Humphry Davy advanced the chemical theory of the pile which, after many years of struggle, eventually superseded the contact theory of Volta. There was a rapid advance in the knowledge of the electric current, of batteries and of the electrolytic process. These experiments produced a profound effect upon chemistry through the electro-chemical theory of Berzelius; and although this has long been given up, the most modern theories have, in a different form, reverted to the view that chemical forces are of electrical origin.

On March 24, 1829, Johann Wolfgang Dobereiner, inventor of the Dobereiner lamp, died. The following is quoted from the *Encyclopaedia Britannica:*

In 1823 a decided impetus was given to the artificial production of fire by the introduction of the Dobereiner lamp, so called after its inventor, J. W. Dobereiner of Jena. . . . .He noticed that spongy platinum in presence of oxygen can bring about the ignition of hydrogen, and utilized this fact to construct his "hydrogen lamp," the prototype of numerous devices for the self-ignition of coal-gas burners.

Crookes announced the discovery of the new metallic element, thallium, on March 30, 1861. Browning in "Introduction to the Rarer Elements," writes:

Some years previous to 1861, Crookes had been engaged in the extraction of selenium from a seleniferous deposit which he had obtained from the sulfuric acid manufactory at Tilkerode in the Hartz Mountains. Some residues, left after the purification and supposed to contain tellurium, were set aside and not examined until 1861 when, needing tellurium, Crookes vainly tried to isolate it by various chemical methods. At length he resorted to spectrum analysis and tested some of the residue in the flame.

The spectrum of selenium appeared, and as it was fading, and he was looking for evidence of tellurium, a new bright-green line flashed into view. The element whose presence was thus indicated received the name Thallium, from *thallus*, a budding twig.

John Napier, inventor of logarithms, died April 4, 1617. The following quotation appears in Hobson's "John Napier and the Invention of Logarithms:"

Napier's conception of a logarithm involved a perfectly clear apprehension of the nature and consequences of a certain functional relationship, at a time when no general conception of such a relationship had been formulated or existed in the minds of mathematicians, and before the intuitional aspect of that relationship had been clarified by means of the great invention of coördinate geometry made later in the century by René Descartes. A modern mathematician regards the logarithmic function as the inverse of an exponential function; and it may seem to us, familiar as we all are with the use of operations involving indices, that the conception of a logarithm would present itself in that connection as a fairly obvious one. We must, however, remember that, at the time of Napier, the notion of an index in its generality, was no part of the stock of ideas of a mathematician, and that the exponential notation was not yet in use.

Humphry Davy was knighted for his scientific attainments, April 8, 1812. Bolton in "Famous Men of Science," writes:

Trinity College, Dublin, conferred upon him the degree of Doctor of Civil Law. Curier said of him: "Davy, not yet thirty-two, in the opinion of all who could judge of such labors, held the first rank among the chemists of this or of any other age." The National Institute of France had awarded him the prize given by Napoleon to the greatest discovery by means of galvanism. And yet all this fame and honor had been won by incessant labor. He writes to his mother: "At present, except when I resolve to be idle for health's sake, I devote every moment to labors which I hope will not be wholly ineffectual in benefiting society, and which will not be wholly inglorious for my country hereafter; and the feeling of this is the reward which will continue to keep me employed". . . . .In 1812 Davy was knighted by the Prince Regent. Only thirty-three, and he had come to great renown!

Isaac Newton was knighted at Trinity College during a visit of the Queen, April 16, 1705. Hart in "Makers of Science," writes:

In 1703, the year in which he vacated his professorship, he was elected president of the Royal Society, and in 1705 he received the honor of knighthood from Queen Anne. His university, too, had once more elected him as its representative in Parliament, and what with the Mint, the Parliament and the Court (at which he was now a great favorite), how different was the general routine of his life compared with the days of his lectures, his experiments, and his calculations!

Yet he still remained a power of the first magnitude in the world of science and mathematics.

Max Planck, the author of the quantum theory was born on April 23, 1858.

On April 24, 1800, Sir William Herschel announced to the Royal Society his experimental procedure first demonstrating the presence of the infrared spectrum. W. R. W.

ABSTRACTS

What Should Science Teaching Accomplish? HENRY HARAP. *Sch. Sci. and Math.*, **27**, 60–9 (Jan., 1927).—Author reviews methods used to determine how courses of study should be determined to satisfy the four needs cataloged—

1. To interpret science as found in newspapers, magazines, etc.
2. To increase enjoyment by exploration, experimentation, and observation.
3. To satisfy natural curiosity about surrounding things.
4. To utilize science in connection with use of common materials.

Courses in science have been proposed, based partially or completely on one of these needs. The study of newspaper articles by Caldwell and Finley, and L. T. Hopkins, as well as others, has been used to formulate courses based on the first need. The collection and cataloging of questions by students themselves as used by Washburne, Caldwell and Eikenberry, and by Pollack illustrate courses based on needs 2 and 3. Author then elaborates on 4th need—particularly from viewpoint of man as consumer, *i. e.*, food, clothing, shelter, and fuel from census reports, direct survey, etc. Author makes second step the gathering of evidence as to what people ought to do from approved standards of consumption, etc., and third step comparison of habits with standards of good living. Such a classification listed 207, of the total 850 knowledges and skills, under science; in particular those pertaining to food, building materials, household articles, household skills, fuels, lighting, heating, and clothing.

Author then elaborates on specific skills and their uses as, for instance, excess of meat in average American's diet and lack of vegetables, energy requirement and calorific value of food received, function of meats and vegetables in diet, preservation of foods, ventilation, lumber (varieties, advantages, and uses), brick and clay products, cabinet woods and substituted finishes, etc. Author concludes that the four major purposes should all be accomplished by the teaching of science—though any course will be somewhat arbitrary as to which need is emphasized most. B. H. B.

The Science Work of the High-School Student from the College Standpoint. R. K. STRONG. *Sch. Sci. and Math.*, **27**, 28–33 (Jan., 1927).—A discussion of aims versus accomplishments of science work in the high school based on facts by study of their methods; and through proper methods, character.

A plea for courses so planned that the teacher kindles a passion for science in the student and nourishes it to its fullest accomplishment with a warning against assuming any knowledge of the subject or those allied to it for a starting point, but then a steady progress as rapidly and as far as the individual can attain. Brief mention of some subject matter is made. B. H. B.

The Use of Highly Volatile Natural Gas Gasoline as a Refrigerant. ANON. *Can. Chem. and Met.*, **11**, 6 (Jan., 1927).—An abstract from the reports of investigations, U. S. Bureau of Mines, by D. Wyant. In carrying out some work requiring temperatures from 48° to 18°F. it was decided to utilize a compressor built to handle natural gas containing gasoline vapor instead of purchasing expensive ammonia equipment. Results were very satisfactory. The expansion temperatures —22° to —36°F. are low enough to extend its use to a wide range. The most efficient pressure was about 120 pounds per square inch. The danger of fire due to leakage appears to be small as a concentration of 1.5 per cent gasoline vapor in air is necessary before the mixture is sufficiently rich in gasoline to support its own combustion or flame propagation; a mixture of most explosive proportions contains about 2.7 per cent gasoline vapor. It is believed that the use of natural gas gasoline as a refrigerant will be found convenient, economical, and useful in many industries. D. C. L.

Atmospheric Nitrogen Fixation Plants in 1926. Developments in Various Countries. F. C. C. LYNCH. *Can. Chem. and Met.*, **11**, 15 (Jan., 1927).—The percentage of nitrogen derived from fixation plants has grown from 1.38 per cent of total output in 1908 to 44 per cent in 1925. The three well-established processes are the arc, Haber and cyanimide processes. Two others, the Housser or explosion process and the aluminum nitride process, are not yet fully commercialized. Germany and Norway both have a surplus for export, while France ranks next in production. The article contains a list of the various types of plants in different countries. There are a total of 59 plants in operation, 6 of which are arc, 6 Haber, 9 Casale, 7 Claude, 4 "American," 2 cyanide, 25 cyanimide, while 28 others are under construction of which there are 26 Casale, 1 Claude, and 1 Housser. The Casale process, developed in Italy in 1920–21, has attracted attention because excessively high temperature and pressure are not required, and automatic action and a catalyst proof against gaseous impurities are claimed. That

number of plants is no clue to output is shown by the fact that two big Haber plants in Germany produce 60 per cent of the world's total fixed nitrogen output. D. C. L.

Has Einstein Killed Time? ALFRED E. LANE. *Sci. Mo.*, **24**, 140–2 (Feb., 1927).—There is an impression that Einstein's theory has abolished time as a separate form of reality and made it identical with space. If we analyze the difference between time and space we find that time refers to change. On the other hand space comes to us from the idea of coexistence. There is no reason in mathematics or philosophy why we should stop, as Einstein does, at four dimensions, nor why we should not have five, six, or seven. L. gives a number of illustrations in which he attempts to show the necessity for a time factor and the impossibility of the non-existence of time.

G. W. S.

Objectives as Determining Factors for Making a Course of Study in Junior High-School Science. Z. BARBER. *Gen. Sci. Quart.*, **11**, 149–68 (Mar., 1927) continued from January, cf. THIS JOURNAL, **4**, 409 (Mar., 1927).—In the actual preparation of a course of study a whole group of people must participate. This article treats of the steps a course of study committee will take to carry out the ideas as developed in the previous sections. The group must think out or analyze the activities of everyday life that demand science knowledge. One such activity, for example, is health. Every citizen uses his knowledge of science in the affairs of the home and the community; in the practical activities around the home and the garden; in the use of mechanical appliances, etc. The committee would keep cards upon which the various activities are listed under appropriate headings such as Health, Home, Civic Affairs, and Intellectual Activities. Of the activities listed and card-indexed only those should be chosen which will contribute as far as possible toward the realization of the general objectives of education. Many lists of such objectives have been made, most widely accepted of which has been the one made by the N. E. A. committee on Reorganization of Secondary Education (Bulletin 35, 1918). Under the seven objectives listed by the N. E. A. committee, the author lists many activities which he recognizes as being normal adult activities. So, for each activity there must be worked out a list of standards of attainment for the pupils. Topics under Standards of Attainment as borrowed from Oakland and Berkeley are listed. One topic with its corresponding abilities, is given as suggestive of another method of procedure that might be used. This is from Bobbitt's work for the Los Angeles school system.

After the material to be taught has been selected and the activities and standards of attainment agreed upon, the course of study committee has still before it the task of arranging this material into suitable topics of study, or units under which the topics are to be presented, and determining in what grade each topic shall be taught. It has been said that the arrangement should be psychological, rather than logical. It is only after several committees have worked on a course of study, and revisions and corrections have been made, that it will become a rich and fruitful course of study. Each one of the following normal and concrete activities that science teaching may make use of is expanded by the author at considerable length: Using things; seeing things work; controlling things; explaining things; solving problems that come up in the child's experience; using out-of-school activities; observing scientific things in their natural setting; observing in the laboratory; observing by charts or pictures; learning by reading; solving problems; telling about things; correlating science with other departments of school work. Then follows the summary, conclusions, and an extensive bibliography. J. H. G.

The Science of Common Things. J. R. LUNT. *Gen. Sci. Quart.*, **11**, 169–83 (Mar., 1927).—A series of four radio talks to boys and girls broadcast from station WEEI. 1. What Do the Blazing Logs Say? The author discourses on the tongues of yellow flames, the sparks, the brown liquid oozing out of the log, the change from white to black, the pile of red coals, the blue flickering flames, the products of burning. 2. A Green Leaf—the Food Factory of the World. The author tells of Dame Nature, what and how she produces: a box of geraniums, their leaves; the microscope and what it reveals of the upper and under sides of the leaf, the cell structure, stomata, chloroplasts, etc. Dame Nature's pantry shelf with its working materials hydrogen, oxygen and carbon and what a wonderful array of foodstuffs is made from these simple ingredients; water and carbon, the raw materials for the leaf factory, the source of water and carbon; their cycles in Nature. 3. Heat, the Great Traveler. Heat travels in three ways: by conduction, convection, and radiation. These are explained by experiments to be performed at home. Light and dark colors and their reflection and absorption of heat rays, with experiments to be performed are noted. Radio, heat, light, photography, and X-rays are all linked together into one chain. 4. The

Merry Dance of Electrons. Experiments with two balloons and a piece of fur. Charging of the balloons, attraction, and repelling; effect of approach of body parts; positive and negative electricity; molecules, atoms, and electrons; the drop of water explained in terms of these particles; the telephone transmitter and the microphone are listed. J. H. G.

Development Recitation in General Science. W. R. KUKETS. *Gen. Sci. Quart.*, **11,** 201–6 (Mar., 1927).—It sometimes happens that at the beginning of a recitation a pupil will ask a question which changes all plans for the period. This question was asked the author: "Has the moon an orbit around the orbit of the earth or around the earth itself?" It was evident to the teacher that by working with this question it would be possible to turn out enough subordinate questions and points to meet the following general science aims: (*A*) To show the relationship between the sun, moon, and earth. (*B*) To show the position that these three bodies must occupy in the universe in order to have an eclipse of the sun, and of the moon. (*C*) To explain the following related phenomena, (1) The seasons, night and day. (2) Circumference of the earth's orbit. The sum total knowledge of what the pupils knew of the subject is given in ten statements. Two diagrams were then put on the board as a result of the pupils' knowledge and the third and correct one developed from the two partially correct ones. J. H. G.

College Expenses. CHARLES FRANKLIN THWING. *Rev. of Rev.*, **75,** 191–2 (Feb., 1927).—A comparison of college expenses now and fifty years ago. College expenses have about doubled in the time covered. G. H. W.

Helium or Helion? J. N. FRIEND. *Nature*, **119,** 199 (Feb. 5, 1927).—When element No. 2 was recognized on the strength of the D_3 line in the chromosphere it appeared not improbable that it was a metal. Now that helium has been isolated, liquefied, and solidified, we know that it is typically non-metallic, exactly like argon and the other inert gases. It's present name, therefore, is anomalous. H. K. M.

The Technique of Vitamin Assay. ANON. *Nature*, **119,** 216–7 (Feb. 5, 1927).—A review of the methods of assay by means of animal experiments which are difficult as well as time-consuming and by means of test tube color reactions which up to the present are not altogether reliable. The more accurate the methods of assay the better is our knowledge of the value of different food or medical products and the greater is the hope of developing methods for the isolation of the accessory food factors in a pure form. H. K. M.

Radio-Activity and the Heat of the Earth. R. W. LAWSON. *Nature*, **119,** 277–8 (Feb. 19, 1927).—Lawson objects to certain portions of Dr. Evan's presidential address to the Geological Society, and especially to the conclusion that "it is, therefore, doubtful whether there is any considerable excess of radio-active energy available for raising the temperature of the earth." The problem of the thermal history of the earth is unquestionably one of great difficulty and in its elucidation much still remains to be done. The effects of uranium, thorium, and potassium cannot be ignored in geothermal considerations and in the absence of any experimental evidence to the contrary we can continue to assert with confidence that practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur. H. K. M.

Illinium. W. A. NOYES. *Nature*, **119,** 319 (Feb. 26, 1927).—A note giving evidence in support of Hopkins in the priority for the discovery of element No. 61 and in support of the name Illinium rather than Florentium. This does not detract from the credit which Professor Rolla should receive for his independent discovery of the element. Both Professor Rolla and Professor Hopkins realize that a large amount of additional work must be done before the element can be fully accepted. H. K. M.

Interionic Forces in a Completely Dissociated Electrolyte. H. HARTLEY. *Nature*, **119,** 322–3 (Feb. 26, 1927).—An abstract from an address on the Ionic Theory of Electrolytic Solutions. Touches briefly on the theories of Sutherland, Bjerrum, Milner and DeBye-Hückel. H. K. M.

Hamstringing the Liberal Arts College. C. HOLLIDAY. *Sch. and Sci.*, **25,** 153–7 (Feb. 5, 1927).—"The true object of the American liberal arts college is the development of the cultural capacities of a student;" consequently, colleges which serve primarily as feeders to medical, dental, law, and other professional schools are falling short of their original purpose. If the larger institutions would create within themselves, pre-professional colleges, in which courses might be taught according to the needs of the students, the arts college would be free to pursue its duties as a producer of cultural education. At present, there is an heterogeneous mixture of students—those seeking cultural education, those interested in professional training, and others who drift

aimlessly on. The author suggests the survival of the latter type—minus a degree. The "American worship of academic degrees has become nothing short of a curse," the author states, and agrees with Thos. Jefferson who said that everyone should taste college, but only a few be permitted to obtain the bachelor's degree.

Since few have the same tastes and intellectual tendencies, the advisability of subjecting all students to the same rigid curriculum is questioned. Because of a lack of coöperation among the different departments of a college and because the average university faculty fails to see education and life as a whole, the ordinary student finds little continuity and interrelationship in the various courses placed before him.

K. S. H.

The Training of a Research Worker in Education. J. C. BAY. *Sch. and Soc.*, **25,** 275–8 (Mar. 5, 1927).—The failure of many research workers in education may be attributed to incompetent guidance on the part of graduate faculties. They fail to make clear to the student the meaning of graduate work. There is little or no co-operation among the various departments and theses are judged without reference to objective standards.

It is recommended, in this article, that the training of a research worker in education include a substantial year of philosophy, a year of mathematical analysis, and a year of statistics, particularly statistical analysis. Such a schedule would not only train a research worker to recognize truth but to discover it in new fields. Science is conceived of as a method of understanding and controlling physical forces, yet how untrained is the average science teacher, and how uninspired is his soul. "He must be born again," the author states, and not until science teachers realize that theirs is a prophetic rôle, will science be properly taught. Teach it not only as subject matter, but also as method; "teach it with crusading zeal as man's means of controlling forces in the building of a better world."

K. S. H.

The University as a Training School for College and University Teachers. V. T. THAYER. *Sch. and Soc.*, **24,** 773–9 (Dec. 25, 1926).—A discussion of the present training of university and college teachers and the necessity of enlisting specialists in the field of education. The lack of understanding between most teachers and students is due in part to untrained instructors who, through ignorance, fail to recognize the needs of their students, or to arouse within themselves a professional interest in teaching. A specialized knowledge and organization of subject matter is essential. Unfortunately, a situation has comparatively recently presented itself in the realization on the part of many of the young instructors that unless they forget the details of teaching and devote the better part of their time to research and writing, promotions and salary increases will be slow.

Because the universities have come to touch the lives of people in many different ways, the original function of teaching has become of secondary importance. The development of college influences has been accompanied by a radical change in the character of the student body, all of which calls for the intelligent adaptation of subject matter and method which, to progressive educators of today, are considered inseparable. The author proposes and discusses a three-fold program which, he says, might appropriately be adopted by every university. This program would provide for: the tangible encouragement of good teaching; some degree of professional training as a requirement for teaching in colleges and universities; and, for the organization of departmental instruction so as to stimulate the interest of a faculty in the scientific study of teaching and the improvement of the teaching method.

K. S. H.

Some Aspects of University Administration. J. C. FUTRALL. *Sch. and Soc.*, **25,** 177–83 (Feb. 12, 1927).—Responses received from questionnaires sent to 175 colleges, regarding their administrative practices, are recorded, compared, and contrasted in this address delivered at the annual meeting of the National Association of State Universities at Washington, D. C.

K. S. H.

Creative Education in the School. H. F. OSBORN. *Sch. and Soc.*, **25,** 55–60 (Jan. 15, 1927).—A discussion of the effect which the discovery of the antiquity of the human race has had on the education of youth. Except for the short periods when culture, taste, and refinement were at their height—when the intellectual and spiritual side of man was at a premium, the brief civilized historic period of six thousand years has made little impression upon human nature and mentality. It was during the long era of prehistoric time that the nature and mind of man were fashioned. The life of every individual depended on keen observation. Imitative powers were universal, and through these powers all that is included under the terms custom, tradition, and culture have been handed down from generation to generation. Imitation has crept into our lives until originality has all but disappeared. We live amidst borrowed art.

music, literature, etc. Flint implements and weapons which have been unearthed indicate that primitive man was not lacking in creative ability and that his grade of intelligence was not so inferior to our own.

We find, as we contrast the mental powers of primitive man with ours of today, that civilization has produced a revolutionary change which has resulted in a disuse of many of those priceless original qualities, modern youth allowing others to do for him what primitive youth did for himself. We are becoming increasingly dependent on mechanical devices which represent the mental efforts of but a few. Since the life of the average person requires little or no mental action, only a small part of our brain, which is considerably larger than that of primitive man, is ever used.

Consequently, a beginning must be made in the home and school toward preserving the creative powers inherited from primitive man. The youthful mind matures and ripens slowly and should be given careful guidance. Every student should be given an opportunity for self development. K. S. H.

Synthetic Compounds Having an Insulin Light Activity in the Normal and in the Diabetic Organism. E. FRANK, M. NOTHMANN AND A. WAGNER. *Klin. Wochschr.*, **5,** 2100 (1926).—The writers have produced a guanidine derivative which they have named synthalin which produces insulin activity when administered orally. One mg. of synthalin leads to the oxidation of 1.1 to 1.2 gm. of glucose and the action is of long duration. The use of synthalin in diabetes removes glucosuria, polyuria, polydispia, and acidosis. Infections concomitant with diabetes heal when synthalin is administered orally. J. C. K., JR.

Stability of Tenth Normal Potassium Dichromate Volumetric Solution. W. M. CAREY. *J. Am. Pharm. Assoc.*, **16,** 115 (1927).—Tenth normal solution of potassium dichromate preserved in a large flint glass bottle with a cork stopper retained its titer over a period of twenty-four years. The writer, however, observed a very slight sediment at the bottom of the bottle. J. C. K., JR.

Effect of Polarized Light on the Pharmacodynamic Properties of Some Drugs. D. I. MACHT AND J. C. KRANTZ, JR. *J. Am. Pharm. Assoc.*, **16,** 106 (1927).—The effect of polarized light on various drugs and galenical preparations was studied. The source of polarized light was from a Nicol prism and from a specially constructed apparatus with glass plates set at the polarizing angle using a nitrogen 500 watt light as a source of light. With tincture of digitalis and cocaine and quinine solutions polarized light produces a change in their pharmacological activity. Such a change is not produced by equal exposures to ordinary light of the same intensity. It is especially interesting to note that these effects are observed with ordinary light as well as ultraviolet light in a polarized form. J. C. K., JR.

The Effect of Ultra-Violet and Polarized Light on Mercurochrome. D. I. MACHT AND JUSTINA H. HILL. *J. Am. Pharm. Assoc.*, **16,** 110 (1927).—Irradiation by powerful mercury vapor lamps both of the air-cooled and water-cooled variety produce no deterioration in the antiseptic or germicidal potency of mercurochrome, so likewise polarized light produced no change in the potency of a solution of mercurochrome. J. C. K., JR.

Effectiveness in Laboratory Work. HERBERT R. SMITH. *Sch. Sci. and Math.*, **27,** 267–71 (Mar., 1927).—A plea for more universal application of the scientific method in teaching chemistry and a criticism of the current textbook, which is characterized as "too much a museum of dead things." The facts in it are dead to modern youth because they are torn from their natural setting. Furthermore, textbooks grow by additions of new developments but without the deletion of old material, and hence contain too much material to master in the time afforded. Textbooks now serve suitably only as reference books since they lack the detail, scope, and style to serve as reading books in chemistry. Another problem is the ungraded group of pupils to be taught as a class.

Author's tests at Lake View High School (Chicago), indicate that for the past three years 58 per cent of those enrolled in his chemistry classes are unable to profit by their individual work in the laboratory. After three years, the author believes the problem has been solved by the "Lake View Group Method of Laboratory Instruction," in which students are classified into two groups on the basis of achievement. The higher group works in the laboratory with little supervision and the lower group is kept together under close supervision while one or two members perform the experiment. The individuals of the group are responsible for the results and interpretation of the experiment and are tested by repeated questioning. Such a method requires no laborious correction of notebooks and is especially adapted to schools having limited facilities and supplies. The author has found that some pupils are able to do three

to four times the work of the slowest student. This fact has caused reorganization of laboratory experiments on the basis of minimum fundamentals for all with extra and advanced work for those capable of doing more. Method has reduced failures to those "who will not work" and has set a high standard of individual thinking and regard for truth. B. H. BALL

Lesson Planning in Chemistry. J. A. ERNST ZIMMERMANN. *Sch. Sci. and Math.*, **27**, 293–7 (Mar., 1927).—Author's experience of 7 years' teaching has led him to adopt the outline method for planning lessons; in particular under the following captions: Occurrence; Preparation; Properties, (*a*) Physical (*b*) Chemical; Compounds Formed by Man; Uses.

The plan is then applied to chlorine as a type subject and filled in with details. B. H. BALL

Thirty-Third Annual Report of the Committee on Atomic Weights. Determinations Published during 1926. GREGORY P. BAXTER. *J. Am. Chem. Soc.*, **49**, 583–90 (Mar., 1927).—Ten elements were the subject of atomic weight researches during 1926, as follows: Boron, nitrogen, oxygen, silicon, chlorine, titanium, copper, silver, iodine, and lead. Baxter and Starkweather have published new determinations of the densities of nitrogen and oxygen, obtained by weighing the gases in 2-liter globes. They calculate, from their data on oxygen, that the limiting value for the molal volume is 22.4144 liters. Robinson and Smith determined the densities of specimens of silicon tetrachloride prepared from silicon of different geological origins. The extreme difference in density found, 0.00005, corresponds to a difference of 0.005 in atomic weight. Batuecas, having determined the normal density of methyl chloride, calculates the atomic weight of chlorine to be 35.465, somewhat higher than the accepted figure. Baxter and Butler have extended their work on titanium, and find its atomic weight to be 47.903. Riley and Baker get a value of 107.864 for the atomic weight of silver, somewhat lower than the accepted figure. Richards and Hall, in a very pure specimen of uranitite from the Black Hills, South Dakota, have found a lead of atomic weight 206.071. From the known amounts of uranium and thorium present in the ore, they calculate the age of the mineral as 1,500,000,000 years. Aston reports on recent work on the isotopes of mercury and sulfur. He finds six isotopes of mercury, atomic weights 198, 199, 200, 201, 202, and 204 in proportions corresponding, respectively, to the numbers 4, 5, 7, 3, 10, and 2. Sulfur is found to contain approximately 3 per cent of isotopes 33 and 34 in the ratio 1 to 3. The 1927 table of atomic weights of all the elements is given. A. P. B.

The Scientific Method. MILTON FAIRCHILD. *High-School Teacher*, **3**, 69 (Feb., 1927).—"The scientific method necessitates intensive, systematic and persistent brain activity, under control against misunderstandings, superficiality, and bias, and in complete loyalty to reality and the truth." The article states that none but those having aptitude, instruction, and training can be successful in the use of the scientific method of thinking. A dozen characteristics of the scientist are listed: He must be (1) sincere and open-minded, (2) alert and alive to truth, (3) poised, (4) discerning and thorough, (5) accurate, (6) inventive and constructive, (7) independent, (8) thoughtful and persistent, (9) industrious and energetic, (10) executive, (11) purposeful, (12) self-confident. The scientific method is described under these general headings: (1) Gather Data, (2) Classify Data, (3) Generalize, (4) Verify, (5) Report, (6) Announce. The article further lists a number (25) of intellectual immoralities such as: (1) Carelessness in observation, (2) generalization beyond one's data, etc. E. L. M.

The Reading Lamp. DUDLEY K. FRENCH. *Chem. Bull.*, **14**, 3–27 (Mar., 1927).—The writer calls attention to a class of books that are arousing an unexpected interest from the average reader. The books include information as to what we are, why we are here, and where we are going. The main object seems to be to bring home certain fundamental facts of psychology in such a way as to suggest possible ways of application. A number of books are reviewed, some of which are: "The Conquest of Self," by Louis E. Bish; "Unmasking Our Minds," by David Seabury; "The Discovery of Intelligence," by Joseph K. Hart; etc. E. L. M.

The Duty of Asking Questions and the Privilege of Drawing Pictures. H. F. MOORE. *McGraw-Hill Book Notes*, 3–4 (Feb., 1927).—The author very cleverly uses a small boy's question "What does God look like?" and his later interest in "drawing a picture of God," as a text for some very stimulating remarks upon the procedure and attitude of the research worker in science. The privilege of asking should be curtailed only by the demand that the importance of the question be proportional to the energy demanded in its answer. In the small boy's picture he sees a type of the scientist's laws, theories, and hypotheses. Here he cautions that there may be many different

pictures of the same thing and yet all be true and that scientists should look upon their pictures as the child will later look upon his picture, as subject to change. "We do not expect the old pictures to be torn down at once from the scientific picture galleries, but rather that both new and the old pictures shall hang on the walls," for a time. This leads to another warning that "Folks. . . . .are very apt to worship pictures." The article closes with the suggestion that the application of lessons learned from the small boy's questions and pictures would prove very helpful to parties upon both sides of some of the present-time religious and scientific controversies. B. C. H.

Measurement in Human Engineering. JOSEPH J. WEBER. *High-School Teacher*, **2**, 360 (Nov., 1926).—"The unified outcome of instruction, management, stimulation, inspiration and guidance is . . . . . maximum development of the pupil's personality." This the author conceives to be human engineering. It involves a two-fold task; a study of the individual's powers and accomplishments and the work of enlarging the accomplishments to the maximum of his native capacity. "Mental measures prove equally useful in both undertakings;" intelligence tests for the first and subject matter tests of achievement for the second. The statement is made that "The history of civilization shows a close relationship between mathematics and human progress. . . . . Education has still far to go in the utilization of quantitative methods; although in the measurement movement. . . . .a very substantial beginning has been made."

The first part of the article considers characteristics of educational measurement tests such as: Standardization, objectivity, central tendency, and reliability.

B. C. H.

The Conquest of Night. HARRY A. STEWART. *American Mag.*, **103**, 55 (Jan., 1927).—This is the story of artificial light from the crude torch to our modern Mazda lights capable of duplicating daylight in color and intensity. Chemists would find interest in: something of the story of the General Electric laboratories, the prevention of inside filming of incandescent bulbs, the improvement of the tungsten filament, the explanation of light as waves of high frequency "broadcast" by disturbances within the atom, why red lights are used as danger signals, artificial sunburn, and what quartz glass means to users of ultra-violet light. B. C. H.

Assault on Freedom of Teaching. Editorial, *Harvard Alumni Bull.*, **29**, 380 (Jan. 6, 1927).—Alumni of larger universities do not easily appreciate the steady pressure that is being put upon many of the smaller institutions to prevent the teaching of evolution in the class-room. S. W. H.

Teachers and Labor Unions. Editorial, *Harvard Alumni Bull.*, **29**, 373 (Jan. 6, 1927).—The question of whether teachers should form labor unions, brought to the front anew by the recent action of the school teachers of Cambridge joining in a body the American Federation of Teachers, is here discussed and the arguments given in this editorial are decidedly on the side of the negative.

"In brief, teachers ought not to unionize in the ordinary sense, because they are public servants. If they affiliate with labor, they take sides in a conflict towards which they should maintain an attitude of impartial judgment from the standpoint of their specific professional ideals of social good and social betterment.

"Teachers cannot properly commit themselves to the advancement of one class as against another any more than they can commit themselves in a body to the Democratic or the Republican party.

"They ought to seek higher pay and a better social standing, but they ought not to strike, whereas labor unions are clearly within their rights when they do.

"In a field of public service, where jobs are protected by legal enactments as to tenure, retirement and pensions, strikes are not only inappropriate but might well be held illegal.

"Teaching differs from ordinary employment just as army service does, just as Calvin Coolidge made it clear that police service does.

"The work of the teachers demands a disinterested devotion to a good beyond that of any class or group or special interest whatever." S. W. H.

The Bureau of Vocational Guidance. JOHN M. BREWER. *Harvard Alumni Bull.*, **29**, 573 (Feb. 17, 1927).—"Vocational guidance aims to help a man discover his abilities, learn about the opportunities and responsibilities of the occupational world, take his first steps in his chosen work, and carry on his readjustments and secure his promotion.

"During the step called 'vocational education' the vocational counselor can bring out those matters of social understanding connected with the occupation, on which success is so often dependent.

"Concrete proof of such dependence is shown in a recent investigation of the

reports which deal with the causes for discharge in industrial establishments: the findings indicate that of 4375 cases of discharge, 2630, or 62.4 per cent were caused by lack of social understanding as represented by insubordination, unreliability, absenteeism, laziness, trouble-making, carelessness, violation of rules, and various types of misconduct. Only about one-third of discharges were due to lack of skill or of technical knowledge.

"In view of these facts, most vocational schools almost completely ignore social understanding and professional schools concern themselves chiefly with technical knowledge." S. W. H.

Specific Objectives versus Adaptability as the Aim of Education. R. R. SCOTT. *Educ.*, **47**, 414-8 (Mar., 1927).—The question at issue is whether the whole of education can be embraced in the analysis of life into specific activities and whether adequate curricula can be built out of these activities.

The opposite of specific objectives, *i. e.*, general objectives, is replaced by the single word adaptability.

Life is made up of activities, it is true, but their multiplicity makes it impossible to practice all of them in school. Also no two individuals have the same life pattern of activities and it is impossible to predict what activities an individual will perform. Again there are few standardized solutions of life.

The requirements of a successful life are constantly changing. Even vocational processes vary so rapidly that the training a man receives in his youth hardly suffices for one life span. If the object of education is to adjust the individual to his environment and to make it possible for him to live the fullest life, it must be remembered that adjustment to changing environment results only from the capacity described by adaptability.

Attention is called to the fact that the specific objective theory, in its pure form, does not rest at all on the contingency of transfer—that is, the doctrine of specific objectives implies that the purpose sought is the ability to perform the activity attempted and nothing more.

A man who has been taught, in addition to many facts, to analyze his experiences and to reconstruct them with reference to some novel situation will be more at home in attacking the unusual. O. J. S.

A Technique for the Construction of a Teacher's Training Curriculum. W. W. CHARTERS. *J. Educ. Res.* **15**, 176–80 (Mar., 1927).—Teachers' diaries, observers' reports, professional literature, and teachers' memory lists, provide sources from which to secure data for an analysis of the duties of high-school teachers. Memory lists provide the material upon which the author has placed the greatest reliance in the present study of teachers' activities. These lists were made by six thousand teachers enrolled in summer schools in 1925. Twelve thousand duties were carded and classified, the product taking the form of six hundred type activities. At the same time that the list of activities was being secured the traits of personality and character of teachers were obtained by the personnel-analysis method.

A frequency table for duties performed differentiates the duties of each class of teachers. The relative difficulty of activities, their general importance, and the relative necessity for teaching them in school, rather than on the job, were then determined. These four criteria—frequency, difficulty, importance, and job-learning—provide a basis for selecting the duties to be covered in a curriculum when all the duties cannot be covered.

The objectives that teachers have in mind in the performance of these activities are determined by the inductive method. The difficulties that teachers encounter in carrying on the activities under the domination of the objectives and traits are collected in certain specified teaching units. The body of the curriculum consists of statements of methods by which these difficulties are overcome. These methods are collected from literature and from teachers in the class-room.

An acquaintance with the principles which underlie class-room methods gives the teacher an intelligent hold upon methods. The failure or success of certain methods used may be explained through the understanding of principles of psychology, sociology, or some other fundamental science.

The author concludes that by the use of this technic a teacher-training faculty may decide upon the kind of teachers it is going to prepare, the traits to distinguish its graduates, the objectives they should have in mind, the duties they are to perform, the difficulties they will encounter, the methods of overcoming these difficulties, and the basic principles underlying the methods used. The material is then to be arranged in pedagogical form in terms of the amount of time that can be devoted to training of teachers, and in terms of the facilities of the school. R. M. P.

Local Activities and Opportunities

Washington Square College. A number of part-time graduate assistantships are vacant in the department of chemistry for the academic year 1927–28. These assistantships carry salaries ranging from $600.00 for students with a Bachelor's degree and no teaching experience up to $800.00 for students with a Master's degree and satisfactory previous teaching experience. In addition, free tuition will be allowed to the extent of eight points a year in courses toward the degree of Ph.D. in New York University.

The duties approximate ten hours per week as laboratory assistant in undergraduate courses in inorganic, analytical, and organic chemistry, and in the conduction of small quiz sections. Holders of these positions will be expected to take up advanced courses in the department of chemistry at Washington Square College toward the Ph.D. degree.

Application blanks and any further particulars desired may be obtained from Professor Kendall, Administrative Chairman of the Department.

University of Florida. Dr. Townes R. Leigh, head of the department of chemistry, has returned from Richmond where he attended the spring meeting of the A. C. S. He reports a most enjoyable trip and many splendid papers.

Prof. Robert C. Goodwin gave the commencement address at the closing exercises of Summerfield High School, on April 15th.

Prof. A. P. Black attended the annual meeting of the Florida Section, American Water Works Association, held in Hollywood, April 12th–13th.

Dr. W. A. Murrill, of the New York Botanical Gardens, addressed the Sigma Xi Club at their April meeting, taking for his subject "Mushrooms, Poisonous and Edible."

Cincinnati Section, A. C. S. The 190th meeting of the Cincinnati Section of the American Chemical Society was held in the Chemical Auditorium of the University of Cincinnati on April 20th. The speaker of the evening was Mr. M. J. Rentschler who is chairman of the Cleveland Section of the American Chemical Society. Mr. Rentschler spoke on "The Peroxides—Their Manufacture and Uses."

Illinois Women's College, Jacksonville, Illinois, is to have a new Science Hall which will cost about $200,000. It will be a three-story brick and stone building of the Georgian type of architecture and will contain laboratories and classrooms for the departments of chemistry, physics, and biology. It will be ready for occupancy next Fall.

Western Reserve University. Western Reserve University, Cleveland, Ohio, announces that Dr. Charles A. Kraus, research professor of chemistry at Brown University, will offer two lecture courses in the forthcoming summer session, June 20th to July 20th. This will be an excellent opportunity for chemists and graduate students in the middle west to become acquainted with Dr. Kraus and his researches.

"The Properties of Solutions in Liquid Ammonia and Their Application to Organic and Inorganic Chemistry" will deal with those phases of research in liquid ammonia for which Dr. Kraus is so well known, with particular emphasis on the physical and chemical properties of salt solutions in liquid ammonia, metallic solutions in liquid ammonia, the organo-metallic compounds, the use of liquid ammonia for synthetic purposes, and the behavior of chemical substances under strong reduction. These lectures

will not duplicate those given by Dr. Franklin last summer, but rather will supplement them. The second course by Dr. Kraus entitled, "Selected Topics Relating to Inorganic Chemistry and Atomic Theory," will discuss modern theories of the structure of the atom, and then will discuss inorganic chemistry in the light of these modern theories.

In addition, collegiate or graduate courses in the following will be offered by the regular staff: General inorganic chemistry, qualitative analysis, the teaching of elementary chemistry, both first- and second-term organic chemistry, physical chemistry, gravimetric and volumetric analysis, a condensed course in quantitative analysis for medical students, food analysis, elementary and advanced chemical microscopy, organic analysis, special chapters in organic chemistry, electrochemistry, chemical industries in Cleveland, glass blowing and apparatus building, and the opportunity for research. The Morley Chemical Laboratory is a modern three-story fireproof building of brick and concrete, and is unusually cool and pleasant for summer study. It is excellently equipped for both undergraduate and graduate study, and houses a large and complete chemical library, available at all sessions.

University of Chicago. George Herbert Jones, who recently gave the University of Chicago a new Chemical Laboratory, has made an additional gift of $250,000. This will make it possible to complete the two proposed units as a single laboratory which will be named the George Herbert Jones Chemical Research Laboratory. The new laboratory will house all research activities and graduate work of the Department and Kent Chemical Laboratory will be used for undergraduate instruction. There will be private laboratories for one hundred research workers including the Staff, together with large laboratories for instruction in Organic and Inorganic Preparations and Physical Chemistry. There will be ample space for enlargement and further development of the Department along special research lines. It is hoped that the laboratory will be ready by June, 1928.

The laboratory will be erected west of Kent and will be connected with Kent on every floor. To the north there will be ample space for further laboratory construction in the future. It is believed, however, that present plans will provide generously for development in the next two decades unless it is decided to undertake graduate and research work in special lines of chemical technology.

A bronze bust of the late Alexander Smith, for many years professor of inorganic chemistry, has been recently presented to the University by Mrs. Smith. As the late Professor Nef was the founder of the department of chemistry and as Professor Stieglitz shared equally with Professor Smith in assisting Professor Nef in the upbuilding of the department, it has seemed fitting that the University should also possess busts or paintings of Professors Nef and Stieglitz and a movement to provide funds for these has been started by a committee of graduates of the department. The busts or paintings of the three men will ultimately be placed in the library of the George Herbert Jones Laboratory, the new research chemistry building about to be erected. Contributions to the fund should be sent to Dr. J. W. E. Glattfeld of the department of chemistry, University of Chicago, who is treasurer of the committee.

University of Nevada. The department of chemistry of the University of Nevada offers a fellowship for next year carrying a remuneration of $600 for the school year. This fellowship is open to young men or young women who have received the Bachelor's degree. It permits the fellow to devote one-half his time to graduate study leading to the Master's degree. Not more than twelve and one-half hours will be required in instruction in the laboratory, grading papers, etc. With reasonable application, requirements for the master's degree

should be completed in two years. Applications should be addressed to Geo. W. Sears, head of the department of chemistry, University of Nevada, Reno, Nevada.

The University of Nevada will act as host for the annual meeting of the Pacific division of the American Association for the Advancement of Science to be held June 22nd to 24th. Professor A. A. Noyes, president of the division and also president of the national organization will deliver an address on "The Periodic Relations of the Elements." A symposium on "The Scientific Problems of an Arid Region" will be presented by specialists in geology, physical chemistry of soils, botany, and zoölogy. A program of special interest to chemists is also being arranged on which it is expected most of the western sections of the American Chemical Society will be represented by one or more papers. The titles of papers intended for presentation at the meeting should be sent as early as possible to Geo. W. Sears, department of chemistry, University of Nevada, Reno, Nevada.

University of Virginia. The catalog of the Summer Quarter of the University of Virginia has recently been issued and distributed.

The faculty for 1927 consists of one hundred and eighteen members, ninety-two men and twenty-six women, fifty-four from the University of Virginia and forty-eight from other colleges and universities, and sixteen from administrative positions in Education.

The courses offered in the Summer Quarter consist of the usual courses in the College of Arts and Sciences, a very large number of courses in Education and special courses in Art, Dramatic Art, Music, Industrial and Fine Arts, Manual Training, Physical Education, Library Economy, Secretarial Courses and Medical Sciences.

Of special interest are the courses offered this year in Modern Foreign Languages. Students who desire to devote their entire time to a modern foreign language may be able to take a full year's work in French, German or Spanish in one Summer Quarter. The work of the Summer Quarter has also been arranged so that pre-medical students can meet fully the science requirements in biology, chemistry, and physics.

The work of the Summer Quarter is fully credited toward degrees in the University and it is possible for either men or women to obtain a Baccalaureate or Master's degree entirely through summer work. There is also a course for teachers leading to the Normal Professional Certificate and the Bachelor of Science degree in Education.

For the benefit of those who need and want beneficial entertainment, a series of concerts, plays, and artistic performances is provided and offered to the students at an extremely low cost.

Carnegie Institute of Technology. The department of mining and metallurgy, College of Engineering of the Carnegie Institute of Technology, offers eight fellowships in mining and metallurgical research, in coöperation with the Pittsburgh Experiment Station of the United States Bureau of Mines and Advisory Boards representing these industries. Fellowships are open to the graduates of colleges, universities, and technical schools who are properly qualified to undertake research investigations.

Each fellowship carries a stipend of $750, paid in ten monthly instalments. Fellowship holders are required to register as graduate students and become candidates for the degree of Master of Science, unless an equivalent degree has previously been earned. Fellows will not be required to pay registration fees. The purpose of these fellowships is the solutions of problems which are of special importance to the mining, metallurgical, and allied industries.

All applicants for appointment to research fellowships should understand the following conditions governing the appointments:

(*a*) Appointment to the position of

research fellow is for a period of ten months, beginning August 15, 1927. A major portion of the time of the research fellow may be devoted to assigned duties in the Experiment Station of the Bureau of Mines.

(*b*) School vacations will not be observed.

(*c*) Any manuscript presenting the results of research shall be published under the joint authorship of that member of the staff of the Bureau of Mines who directed the investigation, as the principal author, and the research fellow as the sub-author. Each manuscript will be published jointly by the Carnegie Institute of Technology, the Bureau of Mines, and the Advisory Boards.

(*d*) Fellows are not permitted to accept other employment for pay during the ten months' period of their appointment.

Application blanks can be secured by writing the Secretary, Mining and Metallurgical Advisory Boards, Carnegie Institute of Technology, Pittsburgh, Pa. Applicants will be required to supply a copy of their collegiate records from the registrar's office of the college, where they have or will be graduated. They will also provide their photographs and names and addresses of at least three persons who are familiar with their character, training and ability together with a statement of their technical or practical experience. Applications are due not later than May 1, 1927.

Neo-Chemto. The Neo-Chemto held a meeting in Canton, Ohio, April 2nd. At this meeting committees reported on testing programs and minimum essentials in high-school chemistry. A test has also been prepared by the committee which will be given in those schools of Northeastern Ohio which wish to cooperate during the coming spring. Dr. N. E. Gordon addressed the group on the subject of "Organization Work in Chemical Education."

Georgetown University. At the meeting of the Chemistry Club of Georgetown University held April 4th, Rev. George L. Coyle, S. J., the dean of the chemistry department, delivered a lecture on the "History and Metallurgy of Iron." The lecture was followed by three very instructive reels on the Manufacture of Steel.

On April twenty-eighth Mr. Anthony Scacciaferro of the Freshman Pre-Medical Class read a paper on "The Story of Bakelite." This paper was followed by motion pictures entitled "The Story of Bakelite."

Hydrogen Was Not Changed to Helium. The dream of the ancient alchemists thought to have been realized by the transmutation of hydrogen into helium by Drs. Fritz Paneth and Peters, noted German chemists, has had to go back to the status of a dream once more, according to a report in the German scientific journal *Die Umschau*. Prof. Paneth has himself retracted the claim that he changed one element into another, because of the discovery of two hitherto unsuspected sources of error in his apparatus. Ultra-minute quantities of helium were held adsorbed in a mass of asbestos, used in the apparatus, and a still smaller amount was dissolved in the glass tubing. These hidden traces of gas came out when heated, and infinitesimal in amount though they were, they registered their presence and thus led to the mistaken impression that helium had come into existence where none had been before.

Prof. Paneth recently spent several months at Cornell University as non-resident lecturer in chemistry and much of his time was spent in research upon the problem of transmutation. His experiments were also repeated in the chemical laboratory at Princeton University with his coöperation. The Princeton chemists are understood to have been unable to bring about the transmutation of hydrogen into helium.—*Science Service*

Recent Books

A Survey of American Chemistry—Volume I, July 1, 1925, to July 1, 1926. Including Reports from Scientific Committees, Division of Chemistry and Chemical Technology, National Research Council. Edited by WILLIAM J. HALE in coöperation with CLARENCE J. WEST. Published for the National Research Council by the Chemical Catalog Company, Inc., New York City, 1927. 257 pp. 13 × 21 cm. $2.00, postage extra.

As indicated in the title, the purpose of this book is to give a brief survey of the contributions made to chemical science by American chemists during the year from July 1, 1925, to July 1, 1926. It consists of thirty-four chapters on "fundamental subjects of present-day interest," each written by an authority on the subject. Some idea of the subjects may be inferred from the following taken at random from the "Table of Contents:" Aluminum—Francis C. Frary; Radium and Radioactivity—Samuel C. Lind; Salts and Non-Metallic Inorganic Substances—James R. Withrow; Metallo-Organic Compounds (Other Elements)—Frank C. Whitmore; Organic Medicinals—Marston T. Bogert; Rubber—William C. Geer; Colloid Chemistry—Harry B. Weiser; Cellulose—Harry LeB. Gray; Catalysis—Hugh S. Taylor; Water and Sewage—Edward Bartow. In the last chapter, Dr. Hale discusses his plan for coöperative research between industries and universities. The chapters average from six to eight pages in length. Of course, it is possible in such limitations only to touch the "high spots" of progress made during the year; however, there is sufficient material to give one a fair idea of the subject, and references to the original articles enable one to go farther in case one desires to do so.

This little book is really a store-house of valuable information. One cannot read it without a feeling of pride in the part that our country is taking in the advancement of chemical science. The book is of especial interest to teachers of chemistry since it will enable them to keep pace with the outstanding discoveries in the various fields of chemical science.

All who are interested in chemistry owe a debt of gratitude to Dr. Hale who originated the idea of publishing this survey and who carried it through to completion, as well as to all those who, without any compensation whatever, so willingly coöperated with him in the enterprise. It is the intention to publish a volume each year and already plans are under way for the publication of the next volume.

WILLIAM MCPHERSON

Experiments in Organic Chemistry, a laboratory manual designed to accompany Outlines of Organic Chemistry. F. J. MOORE, Ph.D., late professor of organic chemistry in the Massachusetts Institute of Technology and H. W. UNDERWOOD, JR., Ph.D., of the department of organic chemistry in the same institution. John Wiley & Sons, New York City, 1927. Third edition, rewritten and enlarged. xv + 133 pp. 10 figures. 13 × 19 cm. $1.25.

As the title indicates this is a laboratory manual written to accompany the "Outlines" by the senior author. Both the textbook and the laboratory manual are intended for students taking a brief course. Here, as in the text, clearness and conciseness are the outstanding characteristics.

The first 41 pages are devoted to general

instructions, including such topics as calibration of thermometers, distillation, crystallization, and qualitative analysis of organic compounds. There are 92 experiments which are well distributed over the whole field of organic chemistry. In each experiment reference is made to the "Outlines" and each is followed by a number of questions.

Prominence is given, both in the introduction and also throughout the book to precautions against fire and personal injury. For its size the book contains much chemistry, clearly and attractively presented. It is admirably adapted to the purpose for which it is intended.

In the preface there is a fine tribute from the junior author to the achievements and character of Professor Moore who was loved by his students and admired by a wide circle of readers.

E. EMMET REID

Pharmaceutical and Medical Chemistry. SAMUEL P. SADTLER, PH.D., LL.D., VIRGIL COBLENTZ, Ph.D., F.C.S. and JEANNOT HOSTMANN, Ph.G. J. P. Lippincot Company, Philadelphia and London, 1927. Sixth edition, revised and rewritten by Freeman P. Stroup, Ph.M. xv + 748 pp. 15 × 23 cm. $7.00.

The book opens with fifty pages of theoretical introduction in which most of the definitions and principles of general chemistry are given in a strictly didactic way. This method is not the one generally followed in modern texts and in the judgment of the reviewer is not sound pedagogically, although for certain practical ends it has some advantages.

The author states that "while intended primarily as a textbook for the use of students in pharmaceutical chemistry, previous editions have had considerable value as reference books by pharmacists, students in medical colleges, physicians and others." Altogether we believe the book to be much better as a reference work than as a text, especially that part covering the fundamental principles of chemistry now generally recognized as part of the course in general chemistry. Presentation of facts in great detail overshadows to a considerable extent the orderly development of the science.

An idea of the great mass of facts presented in the book may be gotten from the statement that more than four hundred acids are named and most of them discussed at least briefly.

The book is well prepared mechanically and the index is quite complete, although such terms as atomic number, amphoteric and solubility product are omitted from it.

As a handy book for the desk of the busy pharmacist, physician, dentist or nurse, it will serve a most useful purpose.

WORTLEY F. RUDD

The Romance of the Atom. BENJAMIN HARROW. Boni and Liveright, New York City, First edition, 1927. iv + 157 pp. 12.2 × 18.4 cm., eight photographs, twelve figures. $1.50.

It is the purpose of this book to give in popular language the history of our knowledge of atoms and of atomic structure. This occupies the first eleven chapters. This much of the book is exceedingly well done for it gives a very good account of the historical development of modern ideas of atoms and ends with a very clear statement of Langmuir's static-atom picture. If the author had stopped at the end of the eleventh chapter, the book would have been smaller by 25 pages, but it would have been incomparably more coherent. The three remaining chapters, entitled Science and Life: The Origin of Life; Science and Life: The Application of Science; and Science and Life: The Scientist as Citizen, have nothing whatever to do with the subject matter of the rest of the book. Irrespective of how well these three chapters may have been written, the reviewer cannot see any excuse for incorporating them in the book. The style of the book is especially clear and interesting, and the author has successfully

avoided the two dangers which ruin most of the other popular books on this subject, for he has omitted practically everything (such as Bohr's Theory) which requires a greater knowledge of physics and mathematics than the average reader may be expected to have, and yet he does not use the fairy tale style which makes most popular books on atomic structure so sickening. For this reason the book will probably find a very useful place on the reference shelf of high-school science classes.

WHEELER P. DAVEY

The Electron in Oxidation-Reduction. DEWITT T. KEACH, assistant professor of chemistry, Yale University, Ginn and Co., Boston, 1926. v + 58 pp. 12 × 18.5 cm. $0.56 list.

Of all the problems which confront teachers of high-school or introductory college courses in chemistry, the one which is likely to precipitate the most acrimonious discussion concerns methods of balancing the equations for oxidation-reduction reactions. From the number of articles which have appeared in THIS JOURNAL during the past few years, it seems that this problem is an exceedingly important one.

It is unfortunate that there is no single method of balancing these equations which is of sufficient generality to cover all cases adequately, not even when the field is limited to inorganic reactions, without at some point introducing assumptions which are difficult to reconcile with experimental facts. The diversity of the methods previously described is due largely to the different compromises to which individual teachers resort in order to attain their own teaching goals. Some teachers are content when their students are able to secure stoichiometrically balanced molecular equations; others desire that their students should have a thorough understanding of all the known factors affecting the course of the reaction and equilibrium involved. The method described in Professor Keach's book aims at some goal between these two limits.

The author apparently had two objectives in mind throughout this book: first, to give a simple method for obtaining stoichiometrically balanced molecular equations, and second, to interpret each reaction in terms of the structures of the atoms undergoing oxidation and reduction, *i. e.*, in terms of the tendency for the atoms to acquire the most stable electronic configurations.

The method of balancing is almost identical with the well-known valence change method which was described in the Alexander Smith texts at least as early as 1914 under the title, "Making equations; using positive and negative valences." Professor Keach's modifications consist in writing separate partial equations for the oxidizing and the reducing agents and substituting a change in the number of electrons in place of a change in valence. To the reviewer these seem to be entirely logical modifications and should help clarify the situation for the students, especially when they are dealing with fusion reactions and others which take place in essentially non-aqueous mixtures. Whether the mechanism of balancing discussed by Professor Keach has any decided advantages over other methods founded upon similar assumptions, such as the one given by Schlesinger in his "General Chemistry" (Longmans, 1926) is for the reader to determine.

As a presentation of this particular method and its correlation with atomic structure the book is good and should be of service to those teachers who like to use such a method. In this light the reviewer has only a few minor criticisms to offer. The method is quite sufficient to handle most oxidation-reduction equations without the introduction of intermediate reactions; therefore, on page 30, it is quite unnecessary to postulate HOCl as the oxidizing agent in chlorine water. Likewise on page 31, it is unnecessary to assume that Na-

OCl is first formed and then decomposes in the preparation of $NaClO_3$. On page 41, the apology for ignoring the formation of NOCl in the oxidation of HgCl to $HgCl_2$ would imply that the production of NOCl is somehow essential to this reaction while actually it represents merely a side reaction for which a separate equation must be written. On the same page it also seems odd that the formation of $HAuCl_4$ should be considered as a separate reaction when aqua regia acts on gold since both experimental and theoretical considerations would lead us to believe that the formation of this complex compound is essential to the oxidation of the gold.

Considering the book as a whole the reviewer is more inclined to criticize the method described rather than the author's presentation of it. Among the shortcomings of the method when applied to reactions in aqueous solutions, are (*a*) too much emphasis on a final molecular equation, (*b*) too little attention to the factors which are important for reactions in aqueous solution, (*c*) little or no application of our knowledge of ionic equilibria, electrode potentials, etc., and (*d*) some of the assumptions which must be made concerning valence. The writer does not feel justified in taking the space to discuss his objections to the method especially since he has given such a discussion in an article (with V. K. LaMer) which is to appear shortly in THIS JOURNAL.

Professor Keach has analyzed in detail a large proportion of the reactions which occur in courses in general inorganic chemistry and qualitative analysis. Teachers who use the valence change method, or one of its many modifications, will find this treatment useful and suggestive. It will also be a serviceable book for supplementary reading by the student.

ERIC R. JETTE

Varnish Fumes Worth Money. Even the smell of varnish is valuable, and it is a waste of good money to let varnish fumes escape from the manufacturers' kettles to become a plague to the workers and a nuisance to the neighborhood, according to Robert Cowen, varnish chemist, who spoke before the meeting of the American Chemical Society in Richmond. Modern types of apparatus, he said, make it possible for volatile parts of varnish materials, now lost, to be recaptured and utilized.—*Science Service*

Vanadium New Member of World's Metal Family. The addition of a new metal, vanadium, to the world's resources, is announced by J. W. Marden and M. N. Rich, research scientists of the Westinghouse Lamp Company.

Vanadium has been known in its compounds for a long time, according to Dr. Marden and Dr. Rich, but in spite of a century of efforts on the part of chemists no one has previously been able to produce it in its pure form. The method employed by the authors is to heat a mixture of vanadic oxide, metallic calcium, and calcium chloride in an electric furnace for an hour at a temperature of nearly 1400 degrees Fahrenheit. After cooling and stirring the resulting mass in cold water, metallic vanadium is obtained in the form of beads.

"The beads of vanadium are very bright, have a steel-white color and are quite malleable, soft and ductile," say the authors. "They can be melted in a vacuum in a high-frequency induction furnace, rolled into wire and worked up into other shapes. As far as analysis can determine, they are 99.9 per cent pure metal.

"There is no known use for this new metal at present, but undoubtedly it will have special properties that will make it useful. Tungsten, for example, was once a useless metal, but is now of inestimable value for filaments in incandescent lamps, for high-speed tool steel alloys and many other purposes. Vanadium may, in time, prove equally serviceable."—*Science Service*

A FEW MOMENTS WITH THE BUSINESS MANAGER

Civilization Has Become a Matter of Applied Science

EACH OF THESE SCIENCES—physics, chemistry, biology, and, necessarily, mathematics—represents a field of powerful inherent interest. They need, therefore, to be intensively cultivated because of their intellectual appeal. There is nothing finer than the search for knowledge, as such; and no further argument need be adduced in support of the endeavor to develop the pure sciences. None the less, two potent additional reasons may be cited. In the first place, the scientific spirit, characterized by the objective and disinterested search for facts, is gradually invading other fields—industry, politics, and law. The more solid and adequate the basic sciences become, the greater authority will scientific method win in realms not yet subdued; the more completely the world of physical, chemical, and biological phenomena can be described and accounted for, the more prestige does the scientific attitude acquire as respects other fields. Again, whether we will or no, civilization has become increasingly a matter of applied science. To be sure, science can be and is misapplied, but this is not to be laid at the door of science. Health, transportation, food, education—these are realms of activity that cannot be properly managed until more is known. The increase of knowledge upon which human welfare depends comes from the laboratories dealing in the most fundamental fashion with the physical and biological sciences.

—*Report of the General Education Board*

NEW EQUIPMENT FOR NEXT YEAR

As the school year draws to a close, we begin to lay plans for the opening of college and school next September. Shall we use the same text? Shall we use the same set of experiments? Shall we teach the course in the same way as of old? Have we reached the ultimate goal in our endeavors as an instructor?

Why not try a new agency in chemical instruction? Something that will vitalize your young people, something that will stimulate and hold the interest of every member of your classes, something that will work for you long after the class or laboratory period, something that will bring other keen-minded young people into your classes with the idea of getting a real appreciation of what chemistry has done, is doing, and will do for the benefit of mankind—that something is the JOURNAL OF CHEMICAL EDUCATION in the hands of each of your students as part of the regular laboratory equipment.

We shall do our share if you will. Write if you are interested.